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AUDIO-VISUAL EDUCATION

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AUDIO-VISUAL EDUCATION is published quarterly

AUDIO-VISUAL EDUCATION aims at fostering interest in the use of audio visual techniques in education among teachers and social education workers.

It provides a forum for teachers and social education workers to discuss and share their day to day experiences in this particular field.

It contains stimulating articles (English and Hindi) on various aspects of audio visual education and is profusely illustrated. It gives the latest information about the Central Film Library. It contains a useful feature entitled "How to Make it Yourself".

Contributions for consideration are invited and, if published, will be paid for at our usual rates.

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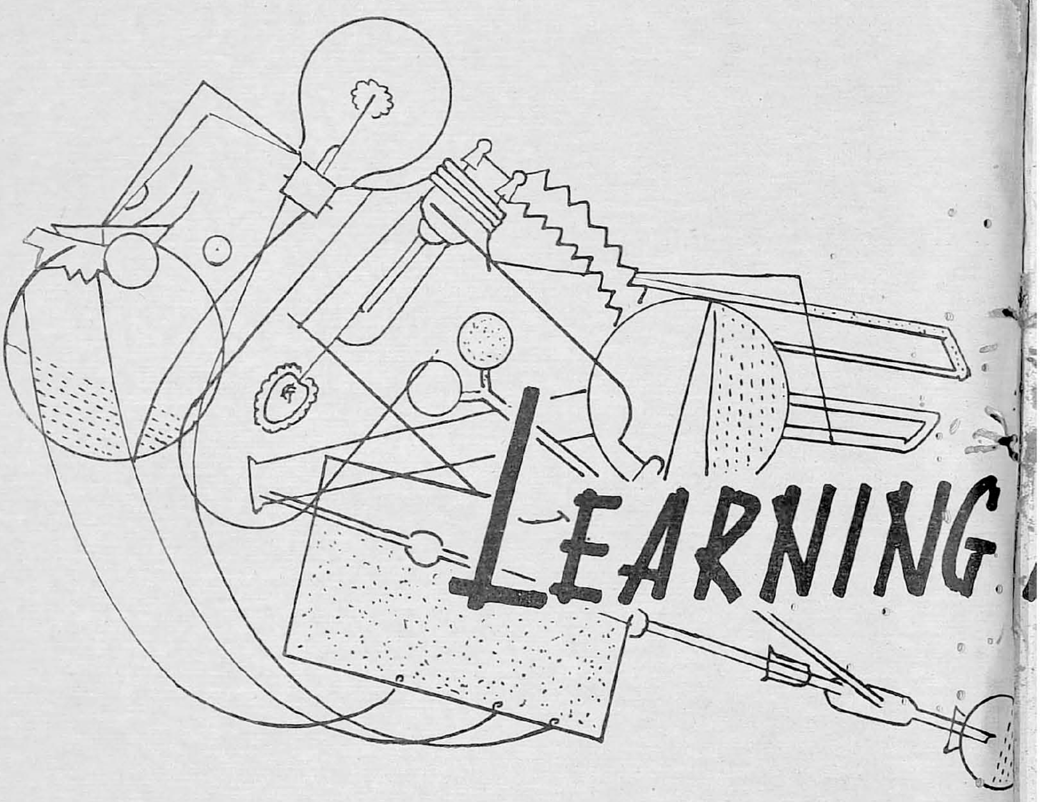
"To learn by discovery we must soak ourselves
the hazards of premature abstraction



LEARNING BY DISCOVERY

Learning by discovery is now being rediscovered. It is currently linked with various new approaches to curriculum development, to calls for thinking and creativity, to producing the Eureka Effect. When Archimedes discovered how to determine the proportion of base metal in Heiro's crown he is supposed to have cried "Eureka !" meaning "I have found (it) !" The term "heuristic", derived from this, dates back to 1860 and is applied to a system of education under which the pupil learns to find out things for himself.

The idea of learning to learn is also an old one. More than three hundreds years ago Comenius wrote that his object was "to seek and find a method by which teachers teach less and learners learn more". In 1873 Herbert Spencer wrote as follows in *Education : Intellectual, Moral and Physical* :

In education, the process, the process of self-development should be encouraged to the fullest extent. Children should be led to make their own investigations, and to draw their own inferences. They should be told as little as possible, and induced to discover as much as possible. Humanity has progressed solely by self-instruction; and—. . . to achieve the best results, each mind must progress somewhat after the same fashion.

This sharply increased interest in learning by discovery is illustrated in several school subjects. The *Growth of Mathematical Ideas, K*-12, the *Twenty-fourth Year Book of the National Council of Teachers of Mathematics,* emphasized that : all students should repeatedly and continuously be "led" to discover or "invent" mathematical concepts and ideas for themselves. Again and again throughout this provocative book, suggestions are made as to how to reach this objective. Fruitful ideas are also found in "Telling Methods *versus* Heuristic Methods" in the *Handbook of Research on Teaching,* edited by N. L. Gage.

The need for students to perceive patterns in solving arithmetic problems has been a long-time concern of Guy T. Buswell. Yet data from his study *Patterns of Thinking in Solving Problems* (University of California Publications in Education, 1956) show that

in our subject, and avoid without depth in understanding."

by DISCOVERY

EDGAR DALE

schools are not achieving any marked success in reaching this objective. "Rather the thinking of the... subjects indicates an absence of a generalized mode of problem solving". Buswell also noted "the need for increased ability to read problems.... The basic difficulty was failure to read critically in order to separate relevant and irrelevant facts". He recommends that teachers shift their major concern from the answers obtained to the methods of thinking by which answers are obtained.

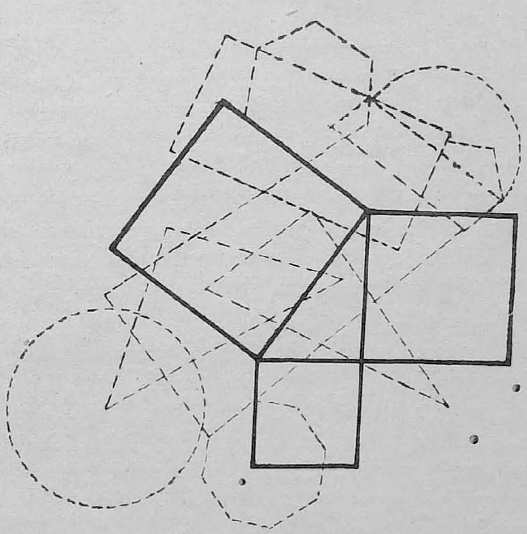
In reading unfamiliar material the pupil is asked to infer the meaning of hard words by noting their context, in order to get clues from the surrounding material. Studies of Deighton, Harrison, and others have shown that many such meanings are difficult to infer. Discovery of new meanings depends not only on external clues, but also on the internal clues of roots, prefixes, and suffixes. Planned programs of guidance are necessary to get full benefit from context clues.

The new methods and materials in physics, biology and other sciences often reclassify the subject-matter of the field, e.g., the thirty-four concepts developed by the Physical Science Study Committee. The weakness of general science study has been that the materials used were too discrete, too unsystematic, and students were unable to put them into workable, generative classification systems. The meanings taught were not functionally filed, not generalized, hence not available for broad use.

Geography, like other subjects, lends itself readily to the memorizing of discrete information. But what substitute is there for memorizing the products of various states and countries? What would happen if the schools helped pupils develop workable generalizations in geography? Facts would still be learned but in the context of a systematic, conceptual approach to solving geographic problems. Children might for example, study where bananas are grown. They would find that they grow best in the hot tropical lands. Then as they studied Mexico, Central America, the West Indies, Ecuador or Brazil, they would expect to find bananas grown there because these countries have the required climate.

They might formulate such questions as the following:

Why doesn't it rain heavily in western Kansas and western North Dakota? Does it have something to do with the rotation of the earth? with mountain ranges? with wind systems? Once students have developed climatic principles from their study, obviously with the aid of the teacher and excellent teaching materials, they can predict the climate, the kinds of industries,



"... all students should repeatedly and continuously be 'led' to discover or 'invent' mathematical concepts and ideas themselves."

the products grown in countries they have not yet studied. Geography, instead of being a boring exercise or a feat of memory, becomes a subject in which a limited number of principles can be skilfully and effectively applied to new situations.

But you cannot make disciplined guesses, inferences, conclusions in any systematic way unless you have a structure, a set of relationships with which to work. When subject-matter is organic (organized), it means that a system of relationships has been established. And relationships create relationships, make inferable rationships possible. One key test of any body of systematic subject-matter, therefore, is its capacity to generate new ideas. Grammar as presently taught does not generate principles by discovery. It is usually memorized without understanding and then forgotten.

Discovery is of two kinds—what we are looking for directly and what we may not be looking for at all. A serendipity, for example, is an unexpected bonus, something gained not by a direct search but as an outcome of a direct search for something else. We are, however, most likely to discover something if we are searching for an answer to a well-formulated question. A quest begins with a question.

We can also learn more than one thing at a time. There can be concomitant or secondary learning. We can aim to discover the *why* and *how* of experience as we are learning the *what*. Furthermore, all learning can develop a vigorous spirit of inquiry, new ways of doing things, of becoming more efficient. A taste for learning can grow and develop.

We can think of our experiences as moving into an ingenious filing system. The way we file our experiences will determine and perhaps stereotype the way we can retrieve them. Our categories for filing can be too limited, too inflexible, and meaning can thus be distorted. Files labled good-bad, black-white, swell-lousy, success-failure can falsify the meaning of highly variable experiences. Two-valued orientation thwarts productive generalization.

How much should the teacher tell the student and what should the student discover for himself? Further, what are the powers of self-discovery among students? Who can make what kinds of inferential leaps? How many need the small, inferential steps of programmed instruction? How many can take giant steps?

These are hard questions to answer. But no matter what the final answer may be, *we should give all students the opportunity to test their powers to make judgments.* They must be faced with problems, puzzles, dilemmas, issues which cause them to "rack their brains". Too often when faced with a question they start reading instead of thinking.

Perhaps they already have the data with which to solve the problem. Many students are told answers to questions which they could figure out for themselves. But this takes time and we may not be organized to do it. We are organized for telling and reciting, not for thinking.

For example, most persons do not know the date of the Gettysburg Address, yet they could figure it out if they knew and understood the first line: "Four-score and seven years ago our fathers brought forth on this continent a new nation. . . ." To figure out the date they must know the meaning of the word "score" (it is 20, not 10, as most students believe) and when our country was founded. So they now add 87 and 1776 and discover the date to be 1863.

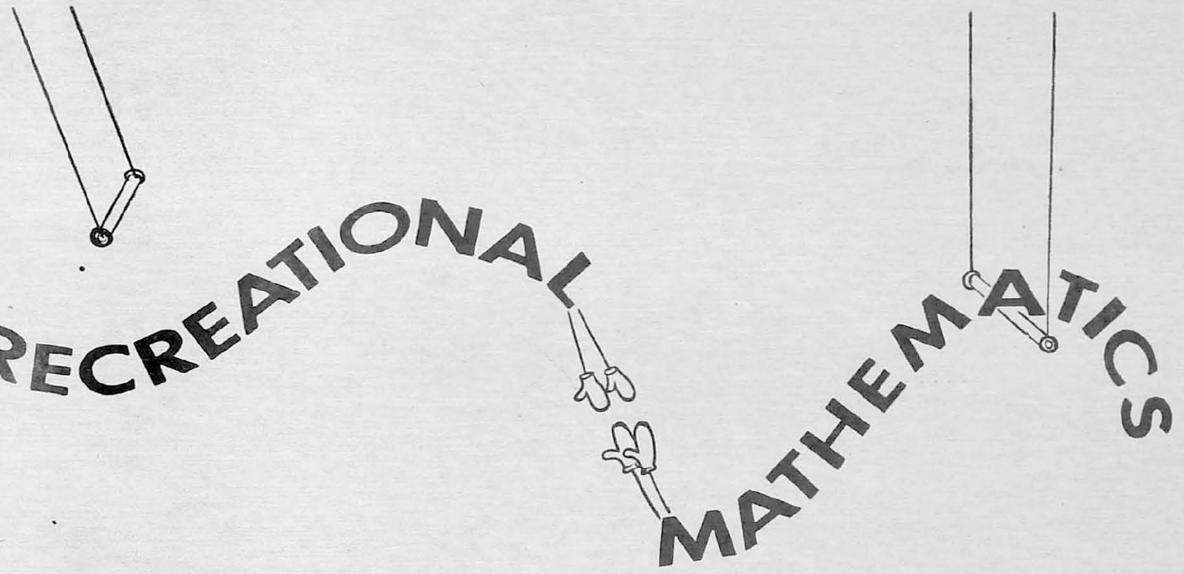
Why isn't there more learning by discovery? In his *Psychology* William James notes that most of us become enslaved to stock conceptions, and says, "Genius, in truth, means little more than the faculty of perceiving in an unhabitual way". But how do we learn to see the world in unhabitual ways? Perhaps paradigms, models, or sets of planned operations may help us create something new.

One approach is to list key assumptions under which an institution is operating—the church, the school, the home. The school, for example, assumes that children should go to school five days a week. Why not four, six, or seven? We usually have about thirty children in a self-contained classroom. Why not thirty-five, with additional specialists or assistants paid out of the money saved by increasing class size? In the typical large university the low-salaried instructors teach freshmen, and the high-salaried professors teach the seniors. Why not periodically reverse it?

In high school or college, students study four or five major subjects. Why not three? Six? What would happen if in certain subjects students did not meet in classes at all, but worked on specially prepared study materials? Would the examinations show less learning? What group learning could be changed to individual instruction? And conversely, what individual instruction might be done better in a group? Why not build schools underground or in taller buildings than we now have?

(*Contd. on p.* 34)

RECREATIONAL MATHEMATICS



G. K. ATHALYE

Fostering interest in extracurricular activities related to regular classroom work, is an art which a painstaking teacher can acquire by practice. By keeping ready with him a collection of a few tricks, anecdotes, mathematical puzzles and some information about unsolved problems of Mathematics, it is possible for him to tide over the emergencies like having to engage classes for other teachers, deal with out-of school-hour study circles and recreational clubs etc. One often comes across interesting problems in popular magazines like *Science Digest, Scientific American,* and even non-scientific journals catering to the needs of not so technically minded individuals, looking for intellectual pastime. It is even possible to construct your own problems to help you illustrate some basic concepts in Mathematics and Physics. It is proposed to pose one such problem in *compound interest* in what follows.

Ramlal was an honest business man living in an old dilapidated house of his ancestors, which needed his attention immediately in view of his expanding business. Demolishing the old house and rebuilding a new structure in its place, naturally compelled him to get rid of junk lying in the attic for ages. While doing this, Ramlal came across an old paper which appeared to him a copy of the promissory note written by his great grandfather for a debt of Rs. 1,000 borrowed by him from his friend belonging to another family in the same town known to Ramlal. Along with the promissory note Ramlal found the letter written by the money-lender. It was rather a strange type of document stipulating how the repayment of the loan could be made either by Ramlal's great grandfather or his descendents, if he himself was not able to pay.

The letter ran thus :

Dear Biharilal,

Since you are in need of money in your difficult days, I can spare for you Rs. 1,000 at present. As you know that I depend entirely on my business of money lending, I always see that money is given to clients who would be sure to use it till it doubles itself, and my rates of interest always adjusted accordingly. I make it a point to see that if the client wants my money just for one year, he pays me exactly double the amount borrowed. But I am not too harsh to my clients. If they want to keep the money for two years I charge the interest at 50% per annum. Compound interest at that rate fetches me Rs. 225 for every Rs. 100 borrowed from me, and used for two years. Naturally if the client wants to use my money for 10 years the compound interest is calculated at just 10% per annum and no more. Thus I ensure that I always get more than double the amount borrowed from me.

In your case, dear friend, we know each other so well that I cannot insist on repayment on a particular date. Please use the sum as long as you want provided you agree or even your grand children agree to pay me the amount including compound interest at the rate, as I have already indicated, inversely proportional to the number of years you or your

family would take before redeeming the debt. Your family is well known for honesty and I do not doubt that you or your children or grand children would make the payment eventually when it is convenient. Please sign the promissory note for Rs. 1,000 and return it to me.

Yours sincerely,

Tarachand Gajadia.

Ramlal could not decipher the date on which Rs. 1,000 were paid to his great grandfather Biharilal, although he knew Gajadia family to whom he could make the payment for final settlement. He also could see that the interest was to be calculated at the rate of 100/n% per annum, if 'n' years had elapsed after the date of the above transaction. He was eager to fulfil his obligation by making the payment exactly according to the conditions of the loan, but how?

Could you help Ramlal to solve his problem? What should be the maximum amount he should pay to Gajadia family, nearest of course to the last whole paisa, to redeem his ancestral debt?

ANSWER

Supposing that Ramlal's family used the amount of Rs. 1,000 for 'n' years, the compound interest charged being at the rate of 100/n% per annum, the total amount to be paid at the end of 'n' years would be

$$\text{Rs. } 1000\left(1+\frac{100/n}{100}\right)^n$$

by usual method of calculating the amount when compound interest is taken into account.

This is

$$=\text{Rs. } 1000\left(1+\frac{1}{n}\right)^n$$

Now since the date on which money is borrowed is not known and since Ramlal is eager to pay the maximum amount permissible to pay irrespective of the duration of the use of the loan, we must consider 'n' as infinite number of years. Rs. 1,000 must be multiplied by the limit of the bracketed quantity when 'n' tends to infinity.

But it can be proved that

$$\underset{n \to \infty}{\text{Lt}} (1+1/n)^n = 2.718281\ldots\ldots \text{etc.}$$

known as the base of Napierian Logarithms.

Therefore Ramlal can redeem the debt by paying Rs. 1,000 2.718281....etc.

=2718 and 28 paise only

Ramlal, without any compunction on his part therefore can pay this amount to Gajadias to redeem the ancestral debt.

Here we have an opportunity to introduce students to various new concepts in Mathematics. In order to show how this constant 'e' is calculated we may start from first principles or lead them on to a study Binomial Theorem, for which idea of permutations and combinations in algebra has to be given.

It is interesting to show how the limit 2.718281.... is attained from considering the steps from first principles.

When $n=1$ $(1+1/n)^n$ becomes $=(1+1)^1=2$

$n=2$ $(1+1/n)^n$ becomes $=(1+\frac{1}{2})^2=2.25$

$n=3$ $(1+1/n)^n$ becomes $=(1+\frac{1}{3})^3=2.38..$

$n=4$ $(1+1/n)^n$ becomes $=(1+\frac{1}{4})^4=2.44..$

....

$n=100$ $(1+1/n)^n$ becomes $=(1+\frac{1}{100})^{100}$

$=(1.01)^{100}$

$=2.7051\ldots\ldots$

$n=1000$ $(1+1/n)^n$ becomes $=1+1/1000)^{1000}$

$=2.7185$ etc.

Otherwise by using binomial theorem, we have,

$$\left(1+\frac{1}{n}\right)^n=1+\frac{n}{\lfloor 1}\left(\frac{1}{n}\right)+\frac{n(n-1)}{\lfloor 2}\left(\frac{1}{n}\right)^2+\frac{n(n-1)(n-2)}{\lfloor 3}\left(\frac{1}{n}\right)^3+\ldots\ldots\ldots\ldots$$

$$=1+\frac{1}{\lfloor 1}+\frac{1.(-1/n)}{\lfloor 2}+\frac{1.(-1/n)(1-2/n)}{\lfloor 3}+\ldots\ldots\text{etc.}$$

$$\therefore \underset{n\to o}{\text{Lt}}=\left(1+\frac{1}{n}\right)^2=1+\frac{1}{\lfloor 1}+\frac{1}{\lfloor 2}+\frac{1}{\lfloor 3}+\ldots\ldots\ldots\ldots$$

$$\therefore e=1+\frac{1}{\lfloor 1}+\frac{1}{\lfloor 2}+\frac{1}{\lfloor 3}+\ldots\ldots\ldots\ldots$$

Thus the constant 'e' can be calculated from the series :

$$e=1+1+0{\cdot}5+0.1666\ldots+0.0416\ldots+\ldots\text{etc.}$$

which correct to 15 places of decimal is to be seen as, e=2.718281828458045....

We shall consider other properties of 'e' in later issues of the journal.

PLACE OF PUZZLES IN EDUCATION

U. S. Nigama

How so very eloquent a speaker, how so very demonstrative and illustrative a lecturer, how so very entertaining and catching the experiments and films or the aids of understanding, none would succeed in bringing home a principle, if the student doesn't actively think with the teacher. It is after his thinking has been activated that the various aids and adjuncts will help the teacher to give, and the student to take, and keep this process alive and useful. All good teachers are familiar with this, and they adopt their own methods to suit their needs.

One such method is the presentation of a problem in the form of a puzzle before the student. The problem stares him in the face. His intelligence is challenged. He finds his ego at stake and he gets actively engaged in solving the puzzle. He attacks the problem from many sides, and looks at it from many angles. He tries to analyse, set and reset the puzzle till he finds the answer. Sometimes it takes him long, sometimes he may strike at the right solution very quickly, and many a time the teacher may have to help him. A wise teacher does not allow his student to go away with a feeling of defeatism. He steps in at the right moment to set him on the right track, the feeling still remaining with the student that he has found the solution. Conducted in this way the student would feel encouraged to accept fresh challenges.

Puzzles make a queer appeal to the old and the young and are popular in every community, literate or illiterate, educated or uneducated. But puzzles should be distinguished from quibbles and magic which have only an entertainment value. In fact the puzzles that a teacher sorts out for his students must involve thinking and not simply call upon the student to catch and uncover some trickery of hands or jugglery of words.

The puzzle should have pertinence to the theme that the teacher is dealing with, or should have direct bearing on the basic principle which is to be introduced to the class. It should also recommend itself for its suitability to the intelligence, knowledge, and achievement of the students. Sometimes it may have to be modified to bring it to the level of the students or to suit it to the availability of material from which it is to be constructed. Handled thus, puzzles can be very useful. It helps the student to recognise the underlying principle, the play of forces in a new and familiar situation. Then it rouses his curiosity in the study of the principle thus unfolded. Having solved the puzzle he feels master of the situation. He may even come out with modifications and improvement, that may be astounding. In most cases he would be able to suggest parallel applications. Indeed when he is able to do this, he has not only undoubtedly understood the principle, but is able to apply it. What more does a teacher want?

Puzzles may be theoretical and imaginative or practical and demonstrative. The approach to the solution may be (i) guess and hit or (ii) analytical. The 'guess and hit' method should not be encouraged. It can soon be rendered infructuous by presenting the same problem with a slight variation in the data. The analytical method which is the right approach shall consist in developing the solution, by argument and counter argument or by trying the solution in varied conditions of the experiment. Only such a scientific approach to the solution is to be commended.

In the following pages a few puzzles have been mentioned. Those can be easily handled at secondary and school level. (Each of these involves some physical principle). I have also mentioned a couple of experiments on nuclear reactions, which may either be presented as a puzzle that will fascinate the student or explained to him directly. These experiments would be appreciated by the student as every school boy, these days, hears and talks about the atom bomb and nuclear reactions. The subject of atomic structure,

radioactivity, nucleus of the atom and nuclear reactions may be introduced with experiments like the ones given here.

Problem 1 : Here is a problem that may baffle many. Take a visiting card and bend it about ½ inch on each side. Place it on a table so as to form a bridge and challenge your students to blow it off, by blowing straight through it.

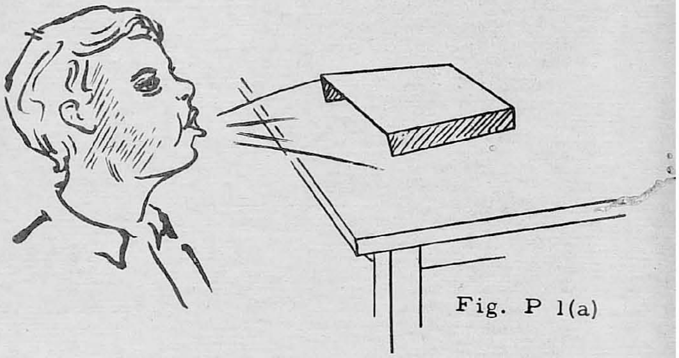


Fig. P 1(a)

You will find most of them trying to blow through the space under it but without any success—Fig. P.1(a). The harder they blow the more it clings to the surface.

Explanation : As we blow through it underneath, a region of low pressure is created there. The greater atmospheric pressure of air from above keeps the card pressed to the table.

This experiment illustrates Burnoulli's principle. Many examples of this may be cited by the teacher, particularly its application in the flight of aeroplanes. The aeroplane wings are so designed that air rushes over their upper surfaces much faster than it rushes past the lower surfaces, Fig. P.1(b). Hence a low pressure is created on the upper side generating a lifting force.

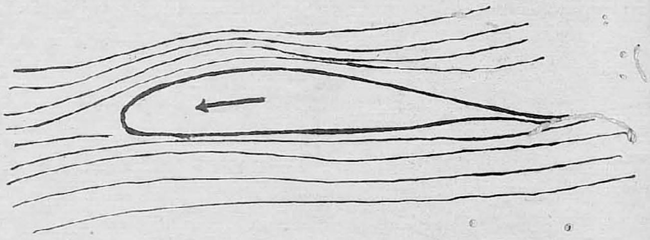


Fig. P 1(b)

Another interesting use of the principle is in the construction of the spray bottle, Fig. P.1(c). The liquid rises in the tube as the air blown across it produces low pressure on the top.

Problem 2 : Take an apple into the class. Ask your students to find its weight without the help of a balance.

Answer : Fill a jug to the brim with water and float the apple in it. Collect the water that overflows in a jar graduated in cc. and find its volume. This is the volume of the water displaced. Also since the apple floats, weight of water displaced must be equal to the weight of the apple. (Principle of floatations). The weight of water displaced is equal to its volume in grams, since the density of water is 1 gm/cc.

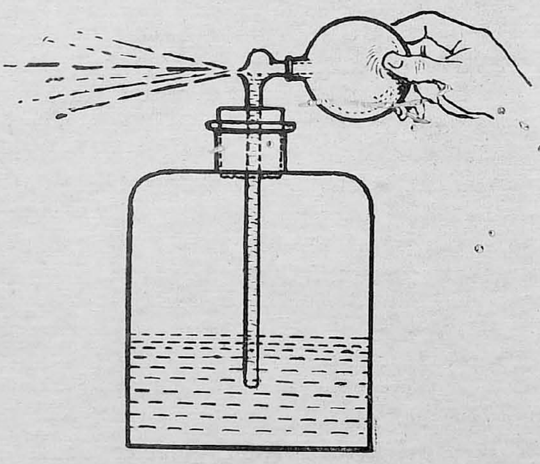


Fig. P 1(c)

Problem 3 : Have a jar filled ¾ with water. Place in it a hollow toy diver with a hole at its feet (See Fig. P. 3.). The toy is such that it floats in open water. On the mouth of the jar tie a well stretched thin rubber sheet. While tying, be sure that there is no air communication between the jar and the outside air. Now press the rubber top. The more you press the deeper will the diver plunge into water. As you release the pressure it comes up. Indeed it obeys your command delivered at the tips of your fingers.

Explanation : As pressure is applied at the top, it is transmitted through air into water (both being confined fluids—Pascal's Law). Because of increase in pressure some more water rushes into the hollow toy, through the tiny hole at its bottom, thereby increasing the weight of the toy. The increased weight makes it sink. When the pressure is released the water that had gone into the toy flows out and the toy comes up again.

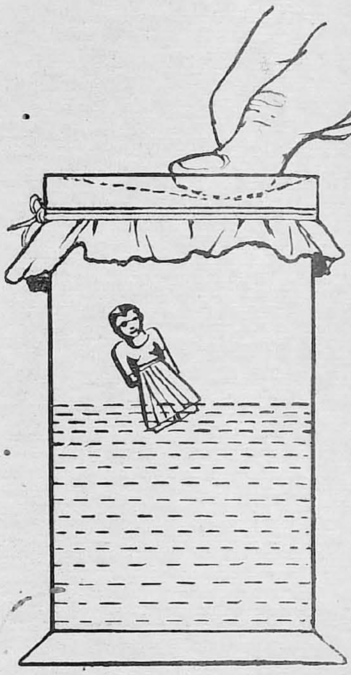


Fig. P 3

Problem 4 : Here is an amusing device based on the principle of Heron's fountain. It gives the impression of perpetual motion, without application of external power.

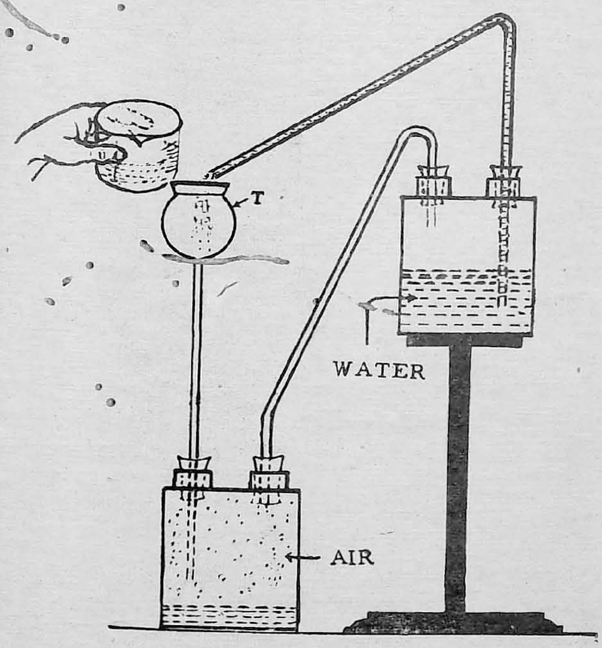


Fig. P 4

Take two Wolf's bottles and fit them up as shown in Fig. P. 4. with tubes and funnel. Place the bottle containing water at a higher level. Use air tight rubber stoppers and air tight tube fitting. The bottle containing water is placed at a higher level. To start the experiment pour some water into the funnel.

It will be noticed that the water starts flowing from the tube T and continues to flow till the upper bottle has been emptied. To lend the experiment a garb of mystery or to make it more intriguing, both the bottles may be covered with opaque paper so that the audience does not see that, to start with, the lower bottle contains only air.

The water that comes in to the lower bottle through the funnel, displaces the air from it, which goes through the tube to the upper bottle and exerts pressure on water in the upper bottle. This pressure is enough to push the water in the upper bottle out of the tube T. It is to be noted that the water is being lifted not from the lower bottle but from the height of water level, in the upper bottle only.

Problem 5 : *Picture in a glass of water.* The picture becomes visible only when the glass is filled with water.

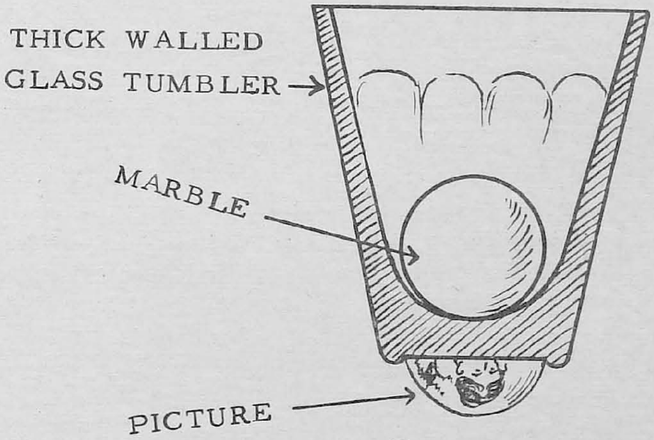


Fig. P 5(a)

Take a thick walled glass tumbler whose interior narrows down to about ¾ of an inch. Paste a picture at its bottom, with its face upwards. Put a trans-

Fig. P 5(b)

parent marble at the bottom of this glass Fig. P.5 (a). Now ask any one from the audience to look into the glass. No picture would be visible. Next fill the glass with water. The picture becomes visible. Fig. P. 5 (b).

The transparent marble acts as a lens. When there is no water and only the glass marble is at the bottom, the picture, being out of its focal length, cannot be seen. As water is filled in, the focal length of the marble lens increases and the picture gets within the focal length of the marble and its magnified image is clearly seen.

Note : When the marble lens is placed surrounded by the medium of water, the refractive index between water and glass being much less than the refractive index between air and glass the focal length of the marble lens increases.

Problem 6 : You are given two plane mirrors, preferably without frames. Pose a question to the audience to arrange these mirrors so that they can see their image as others see them, *i.e.* without lateral inversion.

Answer : Place the mirrors at right angles and adjust your position till you see the required kind of image. Fig. P. 6.

If the image is reflected from one mirror alone, it will show lateral inversion; but if an image of this image is obtained from the other mirror, which is placed inclined in this mirror, there would be another lateral inversion and this double reflection produces the required kind of image.

Problem 7 : *To prepare a water mark on a given piece of paper.*

Wet the piece of paper with water. Place it on a sheet of glass, and then cover it with a blotting paper. whatever design or writing you have to produce on that paper, you impress on the blotting paper, taking care that the blotting paper is not torn off, nor is the pressure applied too lightly. Writing with blunt point with firm pressure will do. Now lift the blotting paper and allow the piece of paper to dry up. When the paper is perfectly dry no impression or writing may be seen. But as soon as this paper is again dipped into water the writing or the design reappears in a transparent contrast. Fig. P. 7.

By the application of pressure the fibres of the paper are disturbed, and this creates a difference in the sucking of water by that part of the paper. This changes the way in which this part reflects light when wet.

Problem 8 : Write a sentence on a thin sheet of paper, so that the writing is visible from the other side also. Now invert the paper upside down. Call the people to read the sentence. They would naturally take plenty of time, particularly if the words written are not very common.

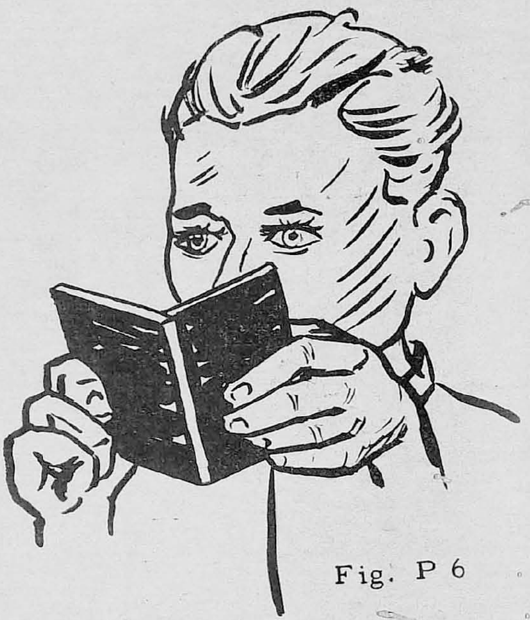


Fig. P 6

You may tell them of a very simple device to read the writing quickly. Have a clean boiling test tube and fill it completely with water. Put a cork, avoid bubbles of air inside the tube. Place this test tube on the inverted writing. Every letter of the sentence will appear erect when seen through this test tube. The distance at which the test tube is held from the writing may have to be adjusted so as to produce the best readable letters.

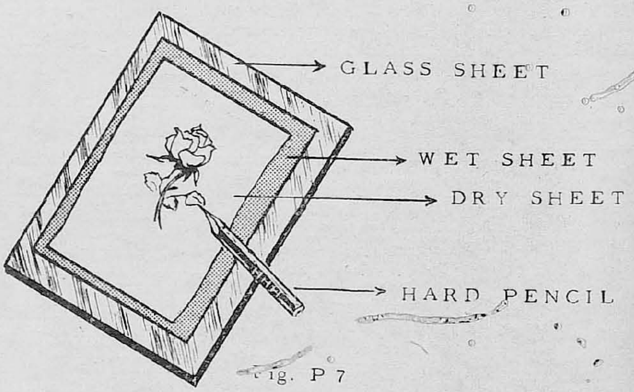


Fig. P 7

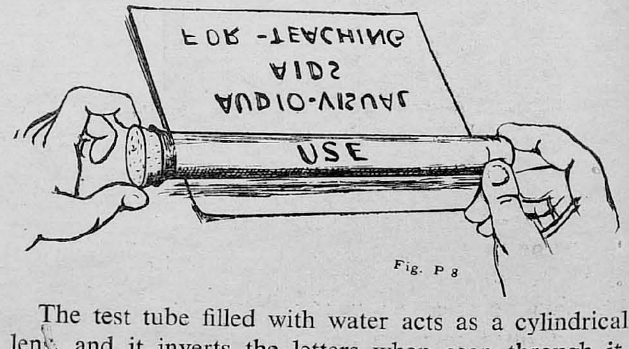


Fig. P 8

The test tube filled with water acts as a cylindrical lens and it inverts the letters when seen through it.

Problem 9 : To make a ray of light go round a curve.

Take a rod of transparent plastic which can be bent. If that is not available, bend a piece of glass tubing, with a broad bore, into some convenient curved shape, fill it with water completely and cover the openings with a transparent film. Now direct a beam of light from a torch at one of the ends. It will be producing a spot of light on a piece of paper held at the other end. Fig. P. 8.

Total internal reflection takes place at the points of greatest curvature and light is thus made to travel towards the other end.

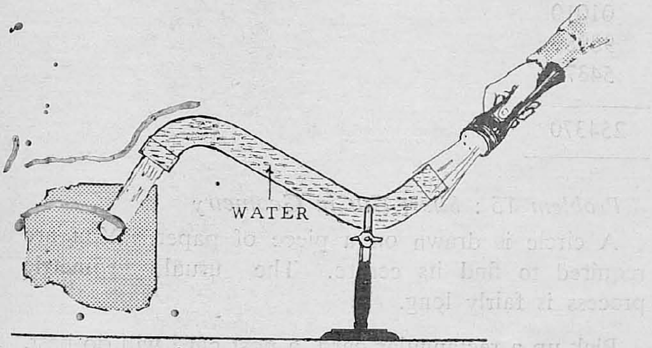


Fig. P 9

Problem 10 : How to use your watch to find direction ?

When you are out for a picnic and the sun is up, choose a small flat piece of ground. If the direction in that countryside is not known to you and your young friends, then you may pose the question for finding direction.

Place your watch on the flat piece of ground with its face upwards. Turn the watch so that the hourhand points towards the sun. Draw a line running from the centre of the watch and point midway between the hourhand and the mark 12 on the dial of the watch. This line will point to the South. Fig. P. 10.

The rule is that you bisect the angle between the hourhand and the number 12. Of course in the forenoon the bisector will lie in a clockwise direction and in the afternoon in the anti-clockwise direction with reference to the hourhand. It is easy to see that at 12 noon the hourhand will point South. The watch must be laid so that the hourhand faces the sun.

In the southern hemisphere, instead of pointing the hourhand towards the sun, we should point number 12 towards the sun. Then the bisector of the angle between 12 and the hourhand gives the direction of the North.

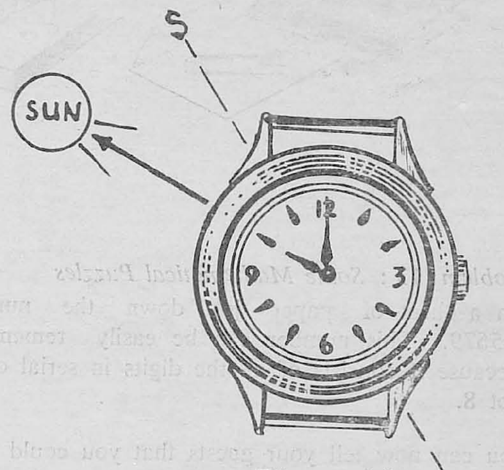


Fig. p 10

Problem 11 : Have you seen nuclear reactions ? If not I will show you here and now.

Close the room and put the lights off. Take off your wrist watch, with a luminous dial. Tell a person to hold the dial about an inch or so from his eye. After a minute or so his eyes will get adapted, to darkness and then he would not see a steady glow but a random succession of individual flashes of light, like so many bright sparks. If you have a magnifying glass, let your friend look at the flashes through it. The flashes will appear sharper and clearer. Each flash signifies the break up of the core, the nucleus of the atom of the radioactive material.

Problem 12 : This show can be further developed into X-ray photography, of course you need a photographic film well wrapped in a black paper. The faster the film the better.

Place the wrapped film with its emulsion side upwards. On this place a ring which you might be able to borrow from any of your friends. If the ring is not forthcoming place a paper clip or a pin or a key on the black wrapper, cover it with a clean sheet of paper and over it place your watch with its dial downwards. Leave these articles undisturbed for a couple of days. Develop the film and you will notice the photograph of the article placed in the film. Fig. P. 12. (on opposite page.)

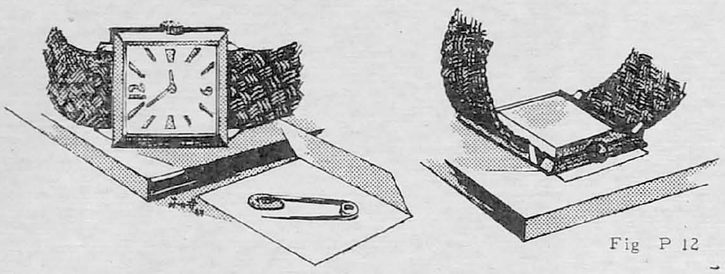
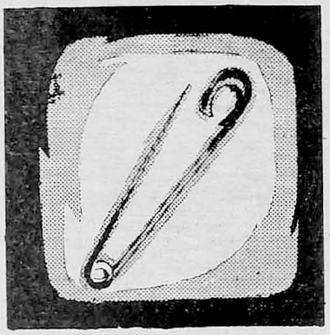


Fig P 12



Problem 13 : *Some Mathematical Puzzles*

On a sheet of paper jot down the number 12345679. This number can be easily remembered because it consists of all the digits in serial order except 8.

You can now tell your guests that you could convert this figure into a figure consisting of the same digit throughout when it was multiplied by a multiplier told by you. Ask your friend his favourite digit. Multiply this figure in your mind by 9 and give the product to the gentleman and ask him to multiply this magic number by that product. As a result he will obtain a figure whose every digit is his favourite one.

Example. Suppose your friends favourite digit is 5. Ask him to multiply 12345679 by 45. Now this product will consist of only fives.

Problem 14 : Quick addition :

Ask your friend to write a five-figure number on the black-board. You then write a five-figure number beneath it. Take care to choose your number so that each digit added to one digit above it will total nine, for instance if his no. is 12576 then your number will be 87423

Now you may ask your friend to put down another five figured number below it. Then you write the next line using the same '9' principle. Invite him to write the fifth number. Then you draw a line below it and write the total starting left. From the last number that your friend wrote subtract 2 and put 2 in front of what is left. That gives the proper sum. See example on opposite column.

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 12576
 87423
 01010
 98989
 54372
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254370
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Problem 15 : *Short Cut in Geometry*

A circle is drawn on a piece of paper. You are required to find its centre. The usual geometric process is fairly long.

Pick up a rectangular card, a post card will do best. Place it on the circle in such a way that one of its corners is on the circumference and the two adjacent edges containing the corner. Cut the circumference at some other points; mark these points. Join these two points by a straight line. Again place the post cards in some other position, a corner point touching the circumference and the containing edges cut the circumference at some other two points. Mark these points as before. Join these by a straight line. The point where these two straight lines cut is the centre of the circumference.

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R. SUBRAMANIAN

PLANETARIUM AS AN AID TO THE TEACHING OF ASTRONOMY

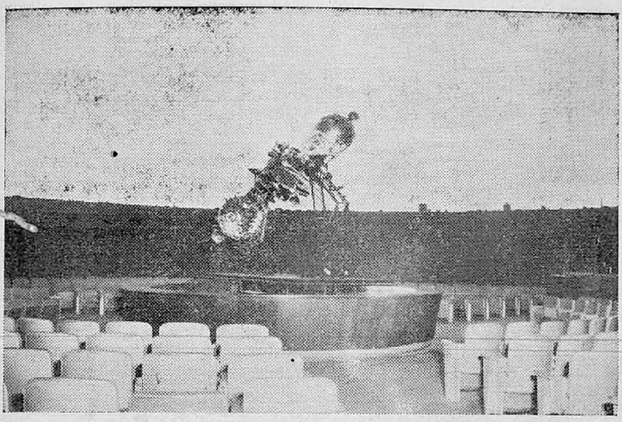
Astronomy is considered to be the oldest of Sciences. Rightly and naturally so as mankind has always found itself a part of the celestial world. The star spangled heavens attracted the attention of people from the very remotest past. In their imagination they were able to see various mythological figures among specific sets of stars. Some of the bright stars were used as landmarks for following the directions. A star like Sirius was used by the ancient Egyptians, perhaps as early as 3,000 B.C. in following the seasonal overflowing of the Nile with reference to the heliacal rising of the star. Countries like ancient China and India had astronomers who worked out carefully the details and timings of eclipses. Aryabhatta, Varahamihira and others wrote standard treaties on Astronomy. As the Science was growing through the ages, celestial bodies and celestial phenomena were being more carefully followed and the sphericity of the earth, its going round the Sun, the galaxies in Space etc. were becoming hard facts. Ever since Galileo turned his telescope to the skies in 1610 A.D., powerful telescopes coupled with auxiliary equipments like Astro-cameras, spectroscopic attachments have enlarged the dimensions and depths of space by tens of thousands and millions of times. We now know that our great Sun, the head of a family of nine major planets with the farthermost Pluto circling at a distance of about 360 crores of miles, is no more than a mere third-rate star among ten thousand crores of stars which constitute just one galaxy among the millions of galaxies scattered in space. All this progress which we owe to hundreds of scientists who have lived and are living in different countries of the world has been very much due to the fact that this is one of the Sciences which has been followed for the sake of Science alone. To this is added an additional facet in recent years with the ushering in of the space era by the launching of the various space probes by the Soviet Union and the United States of America. These have given a new fillip in awakening great interest in Astronomy.

With the aim of spreading the knowledge of astronomy and space Science among the public and the students, the Birla Education Trust established the Birla Planetarium at Calcutta at a cost of Rs. 23 lakhs. The 'heart' of the institution is the Zeiss Universal Planetarium Projector—a complicated precise instrument of optics containing more than hundred lens systems. Easily the most spectacular audio-visual equipment, the instrument is capable of faithfully and accurately creating the image of the starry skies as visible from any point on the surface of the earth. Indeed the instrument can be set to show the set-up of the stars and constellations as was visible at a past date, say 3,000 years ago, or with equal ease to show the set-up at a future date say—10,000 years hence. This giant projection system weighing about two tons, and delicately balanced, is the result of design and development extending over a period of 50 years since the first ideas were conceived by Dr. Oscar Von Miller and Dr. Karl Bassler of Deutsches Museum, Munich in 1903. No doubt there had been attempts much earlier in fabricating working

models and other audio-visual techniques in representing the day-night cycles, earth-moon system, the motions and orbits of the planets of the Sun's family etc. The deutsches Museum indeed contains an elaborate system known as the "Copernican Planetarius" showing in a detailed way the Solar family in the form of a working model. But no accurate representation of the stars and constellations was possible till the Zeiss Planetarium Projector came into the picture. The particular instrument at the Birla Planetarium accurately throws the images of all the stars visible to the eye in their proper positions and comparative brightness (magnitude) on to the inner surface of a hemispherical dome of 75 ft. diameter. One may ask perhaps why we should have a planetarium when there is a natural sky. For one thing there are not many places where one could have many clear nights to watch the stars and to know and recognise them. Neither can one see in a short time (say about 30 minutes) the set-up of the sky through the hours from dusk to dawn. Needless to say that only in the Planetarium can people watch the set-up of the starry sky as one would be able to see at other latitudes. Then there is comfortable seating of 500 visitors in cushioned chairs in the air-conditioned auditorium of the Birla Planetarium which it is next to impossible to be duplicated under the actual open air sky. Lastly there is the added advantage of the running commentary type of lecture with the arrangement for the easy spotting of specific stars by a luminous arrow. The proof of the great appeal of the Planetarium as an audio-visual equipment of Science education lies in the fact that more than 650,000 visitors have come to the Birla Planetarium since its opening about 2½ years back.

Seventeen different astronomical presentations have been so far designed and shown to the public. Some have highlighted the details of the planets of the Solar system while others are concerned with the spotting of various constellations like Orion, Cygnus, Scorpio, Pegasus etc. "Rasis and Nakshatras", deal with the Hindu approach of the signs of the Zodaic. "Venture into space" is an interesting presentation keeping the audience very much alive on the possibilities of man's travel to moon and the planets. Other programmes like "Our Galaxy: the Milky Way", "Hidden wonders beyond the sky", "Life-time of the stars" etc. give to visitors an understanding of the vastness of the universe. Each of these presentations lasts for 45 minutes and there is a question time after the show lasting for about 15 minutes. This discussion after the show is educative and illuminating to the visitors and to the lecturer alike. To carry the message of the stars easily to the public of a big country like India where different languages are spoken, lectures have been arranged in English, Hindi, Bengali and occasionally in other regional languages.

A view of the Birla Planetarium at Calcutta. The Planetarium is the only one of its kind in Asia and the second largest in the Commonwealth.

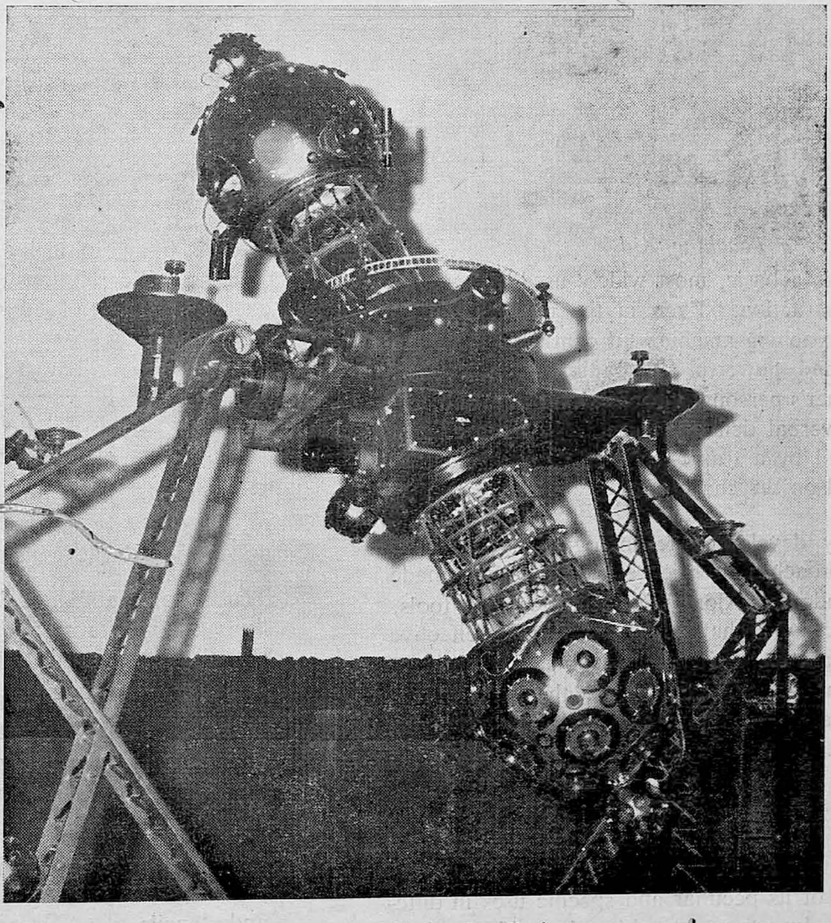


Inside view of the Birla Planetarium. The auditorium can accommodate 500 visitors at a time.

Besides the several themes presented to the general public special graded programmes are conducted for organized school groups of different age levels. About 25,000 school children have so far attended these.

The instrument is also used as an adjunct for teaching Astronomy to the students of the free evening course conducted by the Birla Planetarium. In addition to the eighteen lectures of one hour duration each, the students attend four special presentations. These presentations graphically depict the celestial sphere with the co-ordinates according to different systems, the path and motion of the mean sun and the equation of time, the parallax of stars, procession of the equinoxes, annular, partial and total eclipses etc.

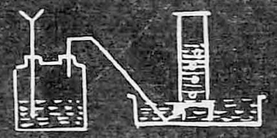
This valuable institution for the teaching and popularisation of astronomy is the only one of its kind in India and one of the only two in the commonwealth, the other being in London.



The Zeiss Universal Planetarium Projector.

S. L. AHLUWALIA

CHALK-BOARDS FOR SCIENCE TEACHING



$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

I. *Chalkboard as a Teaching Aid*

Chalkboard is a basic, most widely used and versatile tool of instruction. Even in the modern age of television and teaching machines, it continues to be the most trusted and powerful companion of a teacher. Next to a teacher's personal visualisation of the subject-matter, is his verbal delivery thereof. This is always to be supported by a frame-work of visualised details to be displayed on the chalkboard.

In a rapidly developing technological society, the ideas and approaches of science have to be made clear to the students. Along with other teaching tools, the wide surface of a chalkboard serves as an effective and essential aid in science teaching. A science teacher need not be an artist to use the board effectively. The basic techniques can be learnt, practised and developed.

II. *Specific Use of Chalkboards in Science Teaching*

The chalkboard is a multipurpose and universal aid in all curricular subjects. But it comes into prominence because of its peculiar and specific uses in different subjects. In science teaching its wide surface, for teaching and display, facilitates the analysis of its specific uses in this subject. Its peculiarity in this subject can be objectively analysed for various scientific principles of teaching as under :

1. The use of chalkboard develops an objective outlook by graphically visualizing and pin-pointing basic relationship of facts and salient concepts. It leads towards generalizations quickly.
2. The use of chalkboard generates a spirit of enquiry by detailing out questions and by motivating step-by-step development of topics.
3. The use of chalkboard develops problem-solving skills by analysing well-defined relationships of basic concepts.
4. The use of chalkboard develops basic scientific skills by facilitating the easy recognition, organisation and tabulation of scientific data.
5. The use of chalkboard facilitates the presentation of dimensional forms, of 3-D objects and apparatus, by providing elements of contrast through the use of coloured chalk.
6. The use of chalkboard facilitates the drawing of oft-repeated common shapes and forms in scientific diagrams by teacher-made templates and stencils.
7. The use of chalkboard focusses attention on procedural details of scientific topics by illustrating processes in a sequential form.
8. The use of chalkboard clarifies technical details and definitions so important in science.

9. The use of chalkboard facilitates the effective presentation of test questions and quiz materials, so essential for recapitulating scientific concepts.

III. *Techniques of Usage*

Keeping in view the varieties of chalkboards and sheets which are of considerable use under different working conditions, a vast variety of techniques of using the chalkboard effectively can be employed. These techniques can be used on most of the available chalkboards. The teacher, by his careful selection, integration and use of the textual details of a subject-matter can employ any one or a combination of the following techniques in science teaching :

1. *The Template Technique* :

When symbols, diagrams and designs are to be repeatedly used for science lessons it is easier to develop these through templates. Templates are cut-outs of cardboard, wood or masonite board, cut along the outline of the design drawn on any one of these materials. The template is held against the board and the outline is drawn with chalk. These templates can be stored conveniently or hung for ready use.

2. *The Pattern Technique* :

Detailed outlines of science diagrams which serve as a basic reference material are punched on heavy tracing paper sheets. The punches are perforated with any sharp-edged pointed material like a nail. The pattern paper is held against the board and a dusty eraser is rubbed against the perforated section of the outline. This makes an outline of chalk dots stick to the board. By free-hand drawings, along these dots, the basic pattern can be completed.

3. *The Subject-matter Outline Technique* :

Procedures, processes and experiments can be detailed out step-by-step through properly worded summaries. Technical terms, definitions, propositions and principles, can be memorised and understood by focussing attention on important words and phrases. Key ideas can be conveyed through contrast by the use of heavy and light lines or through the use of coloured chalk.

4. *The Grid Technique* :

Sometimes, detailed diagrams, outlines of mechanical gadgets, detailed microscopic drawings in biology, etc. are to be enlarged from the textbooks on to the board faithfully in correct proportions. This can be done by drawing small squares on a tracing paper kept on the original diagrams and by transferring the details on the board in bigger squares. The enlargement can be developed according to the desired size.

5. *The Projection Technique* :

The same purpose as in No. 4 can be served by projecting details from an opaque projector or from a filmstrip through a filmstrip projector.

6. *The Hidden Drawing Technique* :

When the process or development of a concept in science is to be depicted in sequential steps, the attention can be focussed on the diagrams which are progressively uncovered by removing the hanging cloth stretched along a wire at the top of the board. This method provides a dramatic element in teaching science.

7. *The Magnetic Board Technique* :

This requires the use of steel chalkboard and small pieces of magnet. Magnets help to fix symbols or light three-dimensional objects used in science teaching on the board.

8. *The Suspense Board Technique* :

Apart from the visible surface of the board, one or more hidden surfaces are available in certain types of boards explained in this article. When contrastive and comparative details of scientific topics are to be explained, some of these can be kept on a surface that is kept hidden. These details are suddenly and dramatically exposed at a psychological moment in teaching. Sometimes the relevant object or model can also be kept hidden and is shown at a crucial moment in teaching.

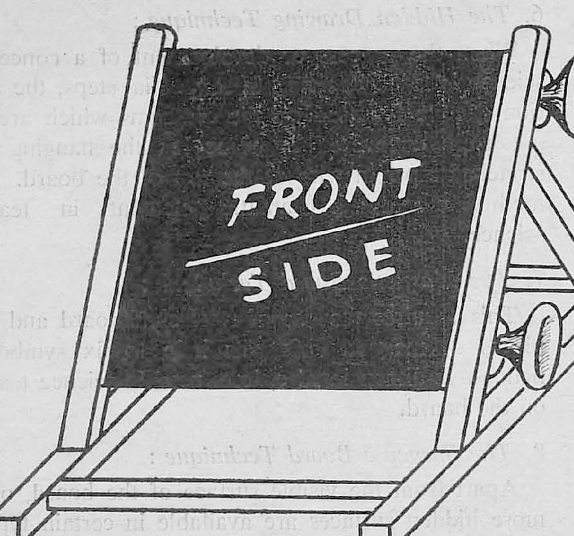
9. *The Roll-up Chalkboard Technique* :

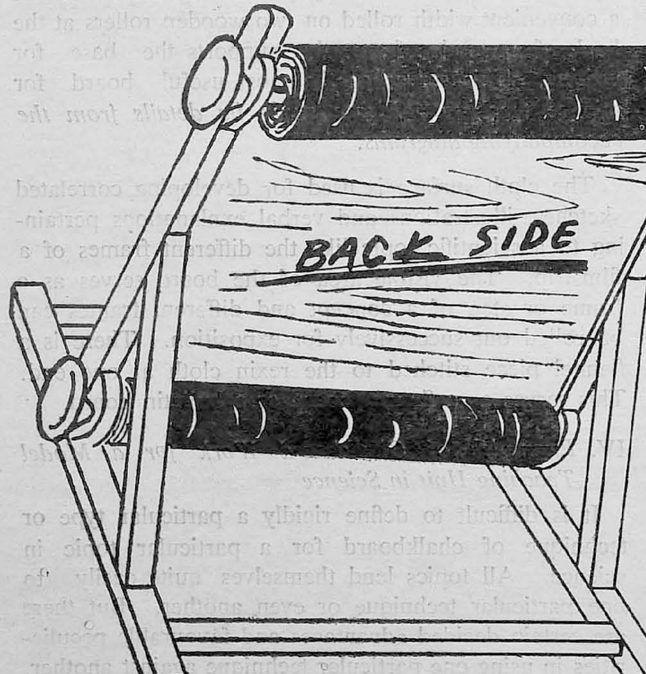
The roll-up board consists of a long rexin cloth of a convenient width rolled on two wooden rollers at the back of a wooden frame that supports the base for writing. This serves as the most useful board for science teaching. *Please study its details from the accompanying diagrams.*

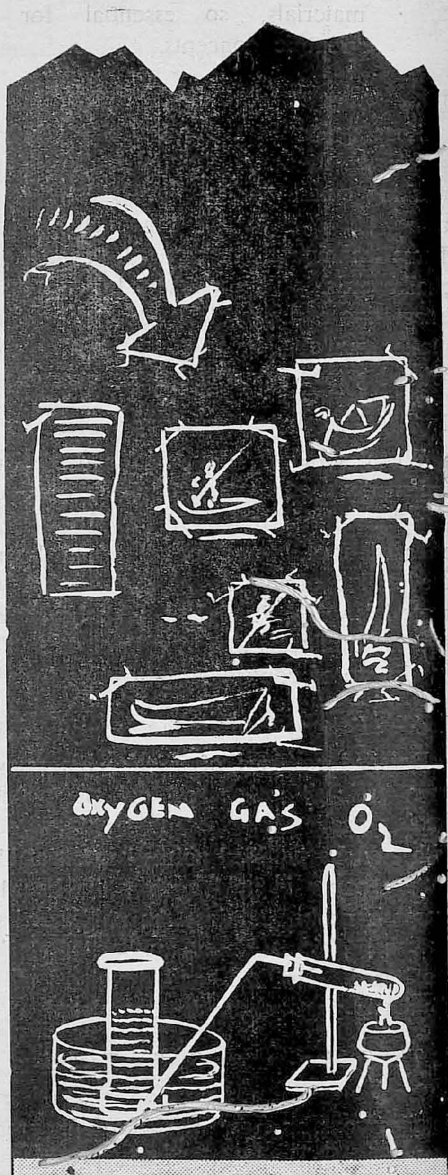
The cloth surface is used for developing correlated sketches, illustrations and verbal explanations pertaining to a scientific topic like the different frames of a filmstrip. The visible area of the board serves as a frame or step of a concept and different frames can be rolled out successively for exposition. There is a flannel piece stitched to the rexin cloth at one end. This serves as a flannel board or a bulletin board.

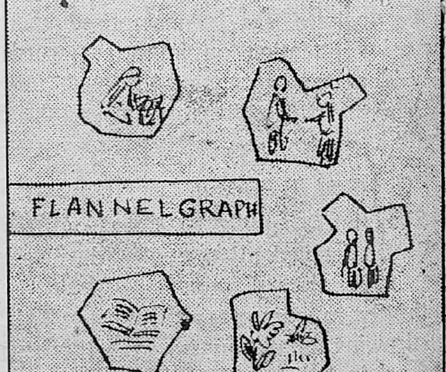
IV. *Examples of Chalkboard Work for a Model Teaching Unit in Science*

It is difficult to define rigidly a particular type or technique of chalkboard for a particular topic in science. All topics lend themselves quite easily to one particular technique or even another. But there are certain decided advantages and favourable peculiarities in using one particular technique against another. Keeping these points in view, underneath we are suggesting examples of chalkboard work for a model teaching unit in science for class VIII. The teaching unit reproduced below is given on pages 8 and 9 of the manual entitled "General Science Syllabus









The Roll-up Chalkboard is a convenient and multipurpose teaching tool.

Classes I to VIII", published by the National Council of Educational Research and Training, New Delhi.

1. Temperature, pressure and humidity are important factors in weather.

(a) Human beings can work efficiently and comfortably when the temperature of the surroundings is 24°C.

(b) Temperature is measured by thermometers, pressure by barometers, and humidity by hygrometers.

(c) Pressure and temperature decrease with altitudes.

(d) Other instruments are also used in recording and predicting the weather; a radiation gauge measures hours of sunshine, a rain-gauge measures the rainfall; an anemometer, the velocity of the wind.

2. Winds are caused by the difference of air pressure at different places.

(a) The temperature of the air in the troposphere layer is the chief factor in determining the pressure of air.

(b) Winds blow from centres of high pressure towards centres of low pressure.

(c) Winds are named after the direction from which they blow.

3. Winds blow over the whole surface of the earth in characteristic pattern.

(a) Winds distribute the energy which falls from the sun unequally upon the earth warming the polar regions and cooling the equatorial regions.

(b) The winds of the earth blow in belts determined by the unequal heating of the earth's surface and by the rotation of the earth.

(c) The winds circulate vertically in a cellular pattern.

4. Energy absorbed, when water evaporates, is distributed by winds and released when water vapour condenses and precipitates.

(a) Clouds are of different kinds.

(b) Storms are of different kinds.

(c) The violence of certain storms indicates the vast amount of energy released. It is the latent energy of the water vapour that is released in storms.

(d) Lightning conductors are used to protect buildings from lightning.

5. Data obtained regarding the temperature of air, its pressure and its humidity can be used for forecasting weather.

(a) High temperature forecasts the formation of low pressure.

(b) Low pressure forecasts strong winds or storm.

(c) High pressure forecasts fine weather.

(d) Greater humidity forecasts low pressure.

Suggested Chalkboard Work

1. (a) Trace and prepare cardboard templates of varieties of thermometer.

(b) With the help of these templates trace thermometers with various readings and also draw related to these the human and living conditions through stick-figure drawings. For example, against the thermometer showing temperature of 24° C, indicate a person amidst congenial working conditions.

(c) Draw detailed schematic diagrams for thermometers, barometers and hygrometers. Use the grid or projection technique.

(d) Use the roll-up chalkboard technique to indicate relationship between pressure and temperature at various altitudes.

(e) Draw schematic diagrams for a variety of weather forecasting instruments such as rain-gauge, anemometer, etc.

2. (a) The roll-up chalkboard technique may be adopted to indicate varying layers of troposphere involving the change in temperature.

(b) The hidden drawing technique can be favourably adopted to show how the winds blow from high pressure towards low pressure.

3. (a) Use the roll-up chalkboard technique to show various kinds of clouds and storms by means of various tones of coloured chalk.

(b) The hidden drawing technique can be very effectively adopted to indicate the vast energy released by the violence of certain storms.

(c) The magnetic chalkboard technique can be dramatically used to show the relationship between lighting techniques of buildings.

4. (a) The subjectmatter outline technique is to be adopted to detail out finally all the technical terms and definitions.

(b) Use the hidden drawing technique to forecast weather under various conditions.

विमलचन्द्रार्य

अष्टम कक्षा के छात्रों के विज्ञान पाठन में श्रव्य दृश्य सामग्री की आवश्यकता

आज सभी क्षेत्रों में परिवर्तन का स्वागत हो रहा है। लोग हर पुरानी चीज को छोड़ने व प्रत्येक नई चीज को अपनाने का अधिक प्रयास कर रहे हैं। इसी का नाम प्रगतिशीलता है। किसी नई चीज़ को अपनाने व पुरानी चीज़ को छोड़ते समय उसकी उपयोगिता या अनुपयोगिता का विचार करना अब कुछ छूट-सा गया है। बहुत विचार करने पर इस कमी या त्रुटि के मूल में शिक्षा का ही दोष दिखाई पड़ता है। शिक्षा मनुष्य को विवेकशक्ति प्रदान करती है। भले-बुरे का ज्ञान कराती है। इसीलिए बड़े-बड़े विचारकों व शिक्षा-शास्त्रियों ने शिक्षा में भी परिवर्तन आवश्यक समझा। "शिक्षा में परिवर्तन" का सही क्या अर्थ है? इसे स्पष्ट करने के लिए शिक्षा में परिवर्तन न कहकर शिक्षा देने के साधनों में परिवर्तन कहना अधिक उचित है ऐसा करने से शिक्षा की कुछ त्रुटियों व कमियों को दूर किया जा सकता है। ऐसा उन शिक्षा-शास्त्रियों व विचारकों का मत है।

कभी हमारी शिक्षा विषय प्रधान रही तो कभी शिक्षक प्रधान। किन्तु अब वे बीती बातें हैं। शिक्षा में अब अमूल-चूल परिवर्तन हो चुके हैं। आज शिक्षा विद्यार्थी-प्रधान है। विद्यार्थी की शक्ति, उसकी रुचि व आवश्यकता को ध्यान में रखकर ही शिक्षा सामग्री को चुना जाता है और नए-नए साधनों से बच्चे को ज्ञातव्य बातें समझाने का प्रयत्न किया जाता है। यही सफल शिक्षा या परिवर्तन शिक्षा कहलाती है।

शिक्षा मनुष्य के सर्वांगीण विकास के लिए दी जाती है। जहां अन्य विषय इस सम्बन्ध में शिक्षा के अंग हैं वहां विज्ञान विषय का अपना एक विशेष दर्जा है। मनुष्य के वैयक्तिक, सामाजिक व शैक्षणिक क्षेत्रों में इसका महत्वपूर्ण योगदान है। छात्रों के नित्य-प्रति काम में आने वाली प्रत्येक वस्तु किसी न किसी प्रकार विज्ञान से सम्बन्धित है। तो भले एवं दक्ष नागरिकों की उत्पत्ति के लिए यह आवश्यक है कि हम विज्ञान के अध्ययन व अध्यापन की ओर विशेष ध्यान देवें और यह प्रबन्ध हमें प्रारंभिक कक्षाओं से ही करना पड़ेगा जिससे कि बच्चे विज्ञान के साधारण व मूल भूत सिद्धान्तों को भली प्रकार समझ लेवें और अपनी ऊंची वैज्ञानिक शिक्षा के लिए एक सुदृढ़ आधार तैयार कर लेवें।

अध्यापन में अनेकों साधन काम में लाए जाते हैं। जिससे कि पाठ सरल, सुबोध व रोचक ढंग से छात्रों तक पहुँचाया ज़ा सके। इन साधनों में से आज हमारी चर्चा का विषय है "श्रव्य-दृश्य साधन"। इन साधनों का शिक्षा के क्षेत्र में अपना एक विशेष स्थान व महत्व है। यह साधन शिक्षा के क्षेत्र में नए हो सकते हैं। किन्तु भारत देश के लिए नए नहीं हैं। इन साधनों का भारत में मनोरंजनार्थ प्रयोग प्राचीन काल से होता चला आ रहा है।

इन साधनों का शिक्षा में प्रयोग अब अत्यन्त हितकर व लाभकारी समझा गया है। इसीलिए शिक्षकों को इनके उचित प्रयोग के लिए उत्साहित व प्रोत्साहित किया जा रहा है। यह साधन विज्ञान पढ़ाने में शिक्षकों का दायां हाथ है। संक्षेप में इनकी उपयोगिता निम्न है :

1—अध्यापक व छात्र दोनों की शक्ति कम खर्च होती है।

2—समय भी कम लगता है।

3—अपेक्षित भाव सही व सच्चे रूप में बालक तक सुगमता से पहुंच जाते हैं।

4—छात्रों में पाठ व शिक्षा के प्रति रुचि उत्पन्न करते हैं।

5—बालक अन्य विषयों में भी प्रवीण व दक्ष हो जाते हैं।

6—छात्र अपने समय का सदुपयोग कर पाते हैं।

7—अनुशासनप्रियता उत्पन्न होती है।

और अन्य अनेकों लाभ इन साधनों के गिनाए जा सकते हैं किन्तु यहां उनका गिनाना ही उद्देश्य नहीं है।

अब पढ़ाने में इन साधनों का कैसे उपयोग किया जाये यह अध्यापक की अपनी सूझ-बूझ पर है। जितने विचारपूर्वक वह इन साधनों का उपयोग करेगा उतना ही उसका अध्यापन प्रभावशाली फलप्रद एवं सरल होगा। इन साधनों के उपयोग में निम्न बातें ध्यान रखने योग्य हैं :

1--उन वस्तुओं का पाठ से सीधा सम्बन्ध हो।

2--वे बहुत अधिक न हों।

3--वे वस्तुएं ऐसी हों जो कुछ न कुछ विशेषता रखती हों (यदि ऐसा न होगा तो कक्षा में सजीवता न होगी। छात्र की रुचि न जागेगी)।

उचित उपयोग या प्रयोग से जहां उनसे अत्यधिक लाभ होता है वहां अनुचित प्रयोग या उपयोग से अत्यधिक हानि भी हो जाती है। कभी-कभी लेने के देने पड़ जाते हैं। इसलिए इनका उपयोग खूब सोच समझ कर करना चाहिए।

इन साधनों का आठवीं कक्षा तक के छात्रों को विज्ञान पढ़ाने में कैसे और कहां उपयोग करना चाहिए इस सम्बन्ध में मैंने क्या व्यावहारिक कदम उठाए हैं उनका अब मैं संक्षेप में वर्णन करूंगा।

जब हम कक्षा में पढ़ाने जाते हैं तो प्रायः पाठ यों आरम्भ करते हैं, "अच्छा भाई अपनी-अपनी किताबें निकाल लो"।

कौन सा पाठ पढ़ना है ?

"मलेरिया"

"अच्छा पढ़ो"

"मलेरिया मच्छर से फैलता है। क्यूलेक्स व एनाफ्लीज मादा मच्छर मलेरिया फैलाने में सहायक होता है।" अधिकतर इतना कहकर हम बस कर देते हैं। किन्तु पाठ को अधिक सुरुचिपूर्ण व प्रभावित बनाया जा सकता है यदि छात्रों को कक्षा में दोनों मच्छरों के चित्र दिखाकर कुछ समानता बोधक प्रश्नों को पूछने के पश्चात् उन दोनों का भेद स्पष्ट करने के लिए भी प्रश्न पूछे जाएं (चित्र संलग्न)।

हमें फूलों के भाग जब कक्षा में पढ़ाने होते हैं तो केवल फूलों के अंगों के भाग मौखिक रूप में बता देते हैं यह अच्छा होगा कि चित्रों की मदद से हम फूल के भागों का या अंगों का स्पष्टीकरण करें। पाठ और भी रोचक बनाया जा सकता है यदि फूल को कक्षा में तोड़ कर छात्रों के सामने उसके विभिन्न अंगों को दिखाया जाए। यदि छात्रों में फूल बांट दिए जाएं तो और भी अच्छा होगा। किन्तु ऐसा करना स्थान व समय पर आश्रित है इसलिए मैं इस बात पर अधिक जोर न दूंगा।

यदि हम बीजों की सुरक्षा से सम्बन्धित पाठ छात्रों को पढ़ाएं तो आधुनिकतम गोदामों की विशेषता बताने के बाद किसी ऐसे गोदाम का चित्र या मॉडल भी दिखा दें तो पाठ अधिक प्रभावशाली होगा।

शरीर के विभिन्न अंगों के कार्यों को समझाने के साथ-साथ हमें उन अंगों की शरीर में स्थिति भी स्पष्ट करनी चाहिए। इससे बच्चों को शरीर के अंगों की स्थिति का ठीक-ठीक पता लग जाएगा।

छोटी कक्षाओं में हमें बच्चों को विज्ञान विभिन्न साधारण प्रयोगों में काम आनेवाले उपकरणों का ज्ञान भी करा देना चाहिए। यद्यपि इनका उनके पाठ्यक्रम में कहीं बयान नहीं है फिर भी उन उपकरणों का ज्ञान कराना रुचिकारक व ज्ञानवर्धक है। उन उपकरणों के मुख्य बीकर, टैस्ट ट्यूब, गैस जार, बी०--हाइव--शेल्फ, बुल्फ बोतल आदि हैं। जिनको चित्रों द्वारा या प्रत्यक्ष रूप से दिखाया जा सकता है।

बहुत छोटी कक्षा में बीजों का बिखरना यदि हम पढ़ाना चाहें तो चिरचिटे या बुढ़िया (आक के बीज) को कक्षा में उड़ा कर या कपड़ों में लगाकर या चिपकाकर दिखा सकते हैं और फिर इसी प्रकार के अन्य बीजों का विवरण व बीजों के इन विशेष गुणों के लाभ भी बता सकते हैं। कुछ खेल-सा तो कक्षा में लगेगा किन्तु बच्चे इस प्रदर्शन में काफी रुचि लेंगे और खेल-खेल में बड़ी काम की बातें समझ लेंगे।

मैंने उपर्युक्त कुछ सुझाव, बढ़ाव व सुधरे तरीकों या साधनों का वर्णन अपने निजी अनुभव के आधार पर किया है। यह आवश्यक नहीं कि बिल्कुल अक्षरशः इनका पालन सब परिस्थितियों में फलदायी या एक-सा होगा और अन्य कोई तरीके काम में नहीं लाए जा सकते। अवश्य और भी मार्ग निकल सकते हैं। हमें प्रयत्नशील रहना चाहिए यही इस लेख का उद्देश्य है।

हां इस सम्बन्ध में मैं एक अत्यन्त महत्वपूर्ण बात कहना तो भूल गया था और वह यह कि हम विज्ञान पढ़ाने वाले अध्यापकों की सहायतार्थ या मार्ग प्रदर्शनार्थ नेशनल काउन्सिल आफ ऐजूकेशनल रिसर्च एण्ड ट्रेनिंग ने जनरल साइंस हैंड बुक ऑफ एक्टिविटीज नामक एक पुस्तक दो भागों में छापी है यह पुस्तक बड़े सोच-विचार कर लिखी गई है और हम लोगों के लिए बड़ी उपयोगी है। हमें उससे पूर्ण लाभ उठाना चाहिए।

CONFERENCE OF AUDIO VISUAL EDUCATION OFFICERS

(A SHORT REPORT)

The National Institute of Audio Visual Education, organized an 'All India Conference-*cum*-Seminar of Audio Visual Education Officers from February 8 to 13, 1965. The Conference was attended by 51 participants comprising Directors of Education, Audio Visual Education Officers of the States, Officers of National Institute of Audio Visual Education and other organizations engaged in the field of Audio Visual Education.

The main objective of the Conference was to provide a common national forum for discussion of audio visual activities in different regions and States at the leadership level and to explore the possibility of and to develop a common basic framework of audio visual programmes.

The major topics for discussion during the Conference were :—

(1) A model for developing State-level A. V. Education programmes and preparation of low-cost visual aids.

(2) Some basic questions regarding Instructional Films and Filmstrips.

(3) Programming Principles and Fundamentals.

(4) Developing Audio Aids Libraries, Suggestions for initiating programmes.

(5) Plans for Crash Programme for A. V. Instruction through Films.

(6) Organization of State Film Libraries and Allied Audio Visual Services.

(7) Methodology of Educational Research with special reference to Audio Visual Aids.

A special feature of the Conference was the organization of an exhibition of Audio Visual Materials and Equipments with the help of private producers and dealers in the field of A. V. Education. The purpose was to give a chance to the leaders in the audio visual field to acquaint themselves with the Indian, as well as, imported materials and equipments available in India and also to have their respective views.

The Conference was inaugurated by Shri L. S. Chandrakant, Joint Director, National Council of Educational Research and Training, who said, "Under the present changing conditions in the country, all research workers, whether in the field or laboratory, have to exchange their knowledge, experiences, competencies, among themselves. Therefore, it is the primary function of the Council to bring together as far as possible, and as often as is necessary, persons working in the field of education to discuss in all seriousness and in all earnestness the problems that are faced by them in their respective spheres". He expressed his happiness that a Conference of this type had been organized particularly in the field that is assuming increasing importance not merely in the context of educational development but also in the context of mass communication.

Stressing the role of the teacher in education, Shri Chandrakant said, "It is the teacher who is the centre of all educational process. Whatever we do in terms of curricula, textbooks, methods etc. we must take into account that all learning processes are built around the functions of the teacher as an individual and as such the participants of the Conference should consider how a teacher should be equipped with all these new methods and techniques in his work in the classroom. The question of priorities should also be kept in mind during the discussions of the Conference.

The valedictory address of the Conference was delivered by Shri K. G. Saiyidain, Member, Education Commission, who while referring to the functions of Education Commission said, "I would like to assure you at this stage that so far as the Commission is concerned, it will certainly examine and it has already begun to examine, amongst other things, this particular problem of audio visual education in which you are interested".

The Conference recommended :—

(1) Such conferences of all India level should be made an annual feature.

(2) NIAVE should send assessment committees to different States to assess their programmes.

(3) States may levy an annual fee of Re. 1/- on every student towards audio visual

funds. This will help the schools to raise their own funds for the purchase of audio visual aids and equipment.

(4) The crash programme for equipping all the Higher Secondary Schools and Teacher Training Colleges with full technical equipment for education through films, radio filmstrips, etc. is suggested.

(5) Efforts should be made to incorporate "Audio Visual Methods of Instruction" as a compulsory paper in the B.Ed. syllabus of Teacher Training Colleges.

SHORT SUMMARIES OF THE PAPERS READ AT THE CONFERENCE

(Readers will be interested in brief summaries of the papers read at the Conference. Lack of space prevents us from publishing the papers in full.—Editor

Paper I : A model for developing State-level A. V. Education programmes and preparation of low-cost visual aids. (by *S. L. Ahluwalia*)

In a State, an Audio Visual Officer is the nucleus of all the ideas and skills in A. V. Education. At present the main functions of State A. V. Department are to :

(i) Develop leadership training programme.

(ii) Collaborate with and to enrich different A. V. Units in Training Colleges in States.

(iii) Develop and coordinate field services.

(iv) Centralize the production of graphic and photographic aids at the State level.

In order to make classroom teachers efficient practitioners of the curriculum, pre-service teacher education for the use of Audio Visual materials is necessary, as it will progressively reduce the need of in-service training in this aspect. At the training colleges it would be ideal to include a compulsory paper or alternatively optional paper in A. V. Aids at all levels. The paper highlights the main areas to be covered during this training.

This paper stressed that a State A. V. Unit should discharge the following functions :

(i) Training of Lecturers of Training Colleges. This will involve training at the National Institute of Audio Visual Education or other places; orientation courses, and professional preparation of selected lecturers.

Shri L. S. Chandrakant, Joint Director, National Council of Educational Research and Training, delivering the inaugural address at the All India Conference-cum-Seminar of A.V. Education Officers' Conference.

(ii) Orientation of Principals of Schools.
The emphasis would be on seminars or workshops.

(a) Workshops of School Teachers.
The emphasis will be on Seminars/Workshops on general/specific topics.

(b) Production Programme should concentrate on integrated teaching aids, subjectwise folios, flip charts, filmstrips, slides and study kits.

(c) Field Services.
The facilities in the form of information, materials and equipment have to be made functional.

The paper also dealt with the production of low-cost visual aids.

Paper II : Some basic questions regarding Instructional Films and Filmstrips. (by *Shankar Narayan*)

This paper broadly analysed the problems connected with the production, distribution, utilization and evaluation of projected Audio Visual Aids such as films and filmstrips. Besides touching various aspects of this subject the paper initiated discussion on :

(i) Various schemes of Audio Visual Education formulated for implementation at the State level. What programmes are being followed in the States for promoting the effective utilization of audio visual instrutional materials.

(ii) Purchase and procuring of suitable projection equipment etc.

Paper III : Programming Principles and Fundamentals. (by *Tilak Raj*)

This paper stressed the need for programmed instruction and explained the growth of interest in and the development of teaching machines or self-instructional devices. In simple language a teaching machine is a mechanical private tutor which incorporates some type of feedback so that the learner may instantaneously be informed of his progress as he proceeds step by step.

The paper highlighted the principles of programmed instructions as :

(i) Learning proceeds most easily if it is acquired step by step.
(ii) Active participation is more effective.
(iii) Reward strengthens or reinforces learning.
(iv) Learning is best when it proceeds at its own pace.

Paper IV : Developing Audio Aids Libraries, suggestions for initiating programmes. (by *Mrs. S. Sidhu*)

Scientifically developed sound media are rapidly being accepted as important instructional materials, as this medium not only provides for perfect participation and self-evaluation but also enhances the value of radio as a teaching device. The paper highlights the importance of recordings in modern classroom.

Paper V : Plans for Crash Programme for A. V. Instruction through films. (by *G. K. Athalye*).

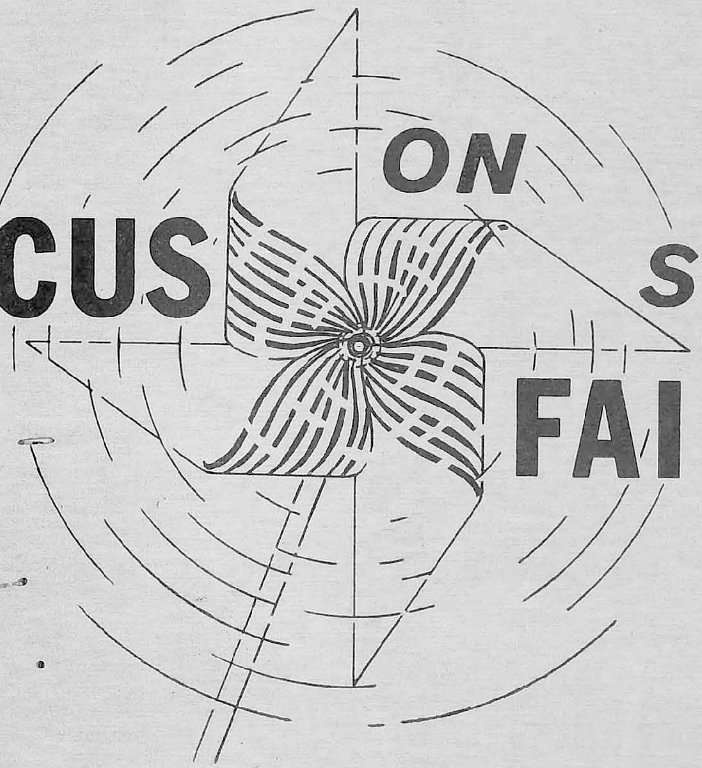
Over a period of last 18 years, attempts have been made half-heartedly to introduce films in classroom teaching. Classroom use of films besides involving provision of equipment, requires well organised and well stocked film libraries, servicing facilities, trained teachers to operate projectors and the correct use of films. It is high time therefore, to work out a crash programme in right earnest, taking into account all the implications and financial involvements in under-

(*Continued on page* 33)

Participants of the All India Conference-cum-Seminar of the Audio Visual Education Officers being introduced to Shri K. G. Saiyidain, Member, Education Commission.

On the extreme left is Shri G. K. Athalye, Director, National Institute of Audio Visual Education, New Delhi.

FOCUS ON SCIENCE FAIRS



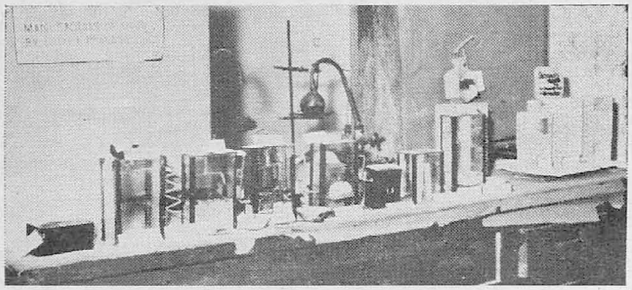
Children indulge in pleasurable play-way activities by motivation or discovery, as a healthy outlet to their tremendous physical reserve of exuberance. Examples of such activities are catching insects, hunting butterflies, rattling train of bricks, blowing out soap bubbles, creating invisible forms and tones through a combination of water colours, balancing toys, swinging on rotating and revolving sea-saws pushing others and sliding down smooth inclined planes etc., etc. All these involve a basic principle that makes them curious at a later stage when their storehouse of experience is stirred by the cause and effect relationships that they are faced with. This is the beginning of an exhibition of a scientific principle; a corporate group-activity of a similar nature guided and controlled by adults becomes a scientific experiment. When such experiments and exhibits are correlated and displayed with a purpose, a science fair emerges.

Science fairs or exhibitions are becoming quite common these days in secondary schools. Generally, schools organize commendable exhibitions of science charts, models and allied teaching aids along with similar instructional materials in other subjects on the occasions of their Parents' Days or Annual Days. The Directorate of Extension for Secondary Programmes is sponsoring and encouraging such science fairs as an offshoot of science club activities all over India. Science fairs constitute a salient extension of the Science departments of secondary schools. The purpose of the science fair is to involve and motivate budding scientists in developing science exhibits and demonstrating experiments. This fosters a healthy spirit of competition and promotes learning by discussion and experimentation. This promotes the growth of direct purposeful educational activities which motivate interest and learning in science. The Directorate has so far sponsored about 300 science fairs at the district level, 84 at the regional level and two at the State level. The science exhibits are brought up to the State level, after being selected at the district and regional levels.

We have surveyed the science exhibitions and fairs in Delhi State, for the past two years. This year too in the month of January and February, 1965, four Zonal Science Exhibitions and Fairs were held at different centres in Delhi. The standard and quality of exhibits was quite commendable at all these four zones. As an example of the various dimensions of the science fair activities, underneath we quote

extracts from the report of one organizer of one of the zonal fairs in Delhi.

"The Higher Secondary Schools of Zone IV did pioneering work in organising a science fair last year at Kingsway Camp. Some other zones followed it. This time we have introduced two new features in our Science Fair. One is that of paper readings by the budding scientists and the other is the talks by eminent scientists. The quality of the papers read by the young scientists has been considered to be very high and the talks by the scientists have also been very popular. Other zones are likely to follow us in this respect also.

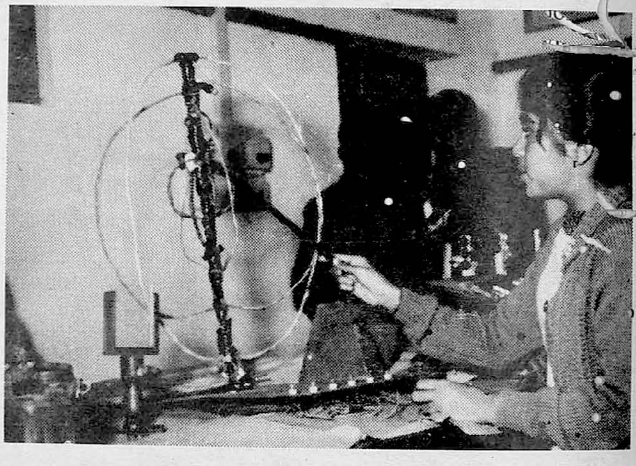


A view of one of the sections at a "Science Fair".

"It is very heartening to note that the quality of exhibits contributed to this fair, on the whole, has been considered to be very high by the visiting scientists. Many of the exhibits have been considered to be based on original ideas. Certain devices have been exhibited which if made use of in the offices can reduce the number of peons employed without any loss of efficiency. There are exhibits which if utilised in household, hospitals and factories can increase efficiency and reduce drudgery. There are exhibits explaining the scientific principles, while there are other exhibits based upon the application of these principles. It is further gratifying to note that many of the exhibits have transcended the limitations placed by the prescribed syllabus and the young scientists are making efforts to free themselves from the bondage of syllabus and examinations. The solar cooker and radar model have been specially mentioned by the correspondent of the "Hindustan Times".

"Our fair consist of four sections and the statistics of the exhibits are as follows :

No. of School participating	Physics 52	Chemistry 45	Biology 11	Gen. Sc. 26	Total
Models	150	73	25	50	298
Charts	97	81	36	43	257
Teaching aids	24	8	17	40	89
Scrap Books	—	8	38	24	70
Science Quizzes	9	24	5	—	38
Demonstration of expts.	10	30	7	—	47
Paper Reading	2	16	4	—	22
Total	292	240	132	157	821



Science Fairs, if properly organized, become very popular with students.

The quality and originality of the exhibits has not only attracted the attention of university professors, students of polytechnics and the press correspondents but they have also attracted the members of the school T. V. team. We are proud of it.

Four different teams of judges were drawn out of university professors and eminent scientists. Each team spent from four to six hours for selecting the best entries for awarding the prizes. They were minutely examined and every entry was scrutinized. This science fair has been a big draw and more than twenty thousand men, women, boys and girls have visited it within two days."

FILMS FOR SCIENCE EDUCATION

Nobody will question the positive utility of film. You will always get an exuberant chorus of full-throated yes' whenever you confront the class with a question : Would you like to see films ? Such a welcome, highly rejuvenating and motivating activity as viewing a film in the classroom has decided advantages and tested values. More than forty years of research in film appreciation, discrimination, critical viewing and listenability corroborate this. The role of films in Science, basically is to develop an acquaintance with the material world and to nourish the scientific habit of mind.

Instructional films in Science, built around curricular topics, provide basic elements in scientific exploration, demonstration and discovery.

(1) They depict the methods or processes not directly demonstratable with special pictorial demonstrations involving complexity of intermediate steps. Salient examples : *Methods of Preparing Vaccine, Methods of Fighting Forest Fires, etc.*

(2) They depict the action observable vicariously by bringing the world into the classroom. *Salient examples* : *Origin of Icebergs; Responses of Organs to Various Stimuli, etc.*

(z) They simplify the observable action by eliminating the irrelevant details. Examples : *Operation of Individual Parts of Gasoline Engine.*

(4) They depict the unobservable action through animation, a progressive series of drawings projected in relation to each other in such a manner that motion is simulated. Examples : *Sound Wave Phenomena; Action of Heat, etc.*

(5) They depict the action which is unobservable because of the slowness of the moving object. Special use is made of the time-lapse photography here. Examples : *Movements Accompanying the Opening of a Bud; Diffusion of a Gas Through Another Gas.*

(6) They simulate reality through recorded sounds or sound effects. Example : *Roar and Rumble of an Active Volcano.*

(7) There is a unique technical versatility of this medium by making use of photographic tricks. By photomicrography, films depict action where microscopes or microprojectors are used. *Activities of Micro-organism* is a cogent example of this case.

PHYSICS

1. **Junior Science Series in Four Parts**				
McGraw ..	..	English	15 mins	530·1
2. **Gravity**				
Coronet ..	..	English	11 mins	530·1
3. **Preface to Physics**				
EBF	..	English	15 mins	530·1
4. **Air in Motion**				
McGraw ..	..	English	11 mins	530·72
5. **Air Pressure**				
McGraw ..	..	English	11 mins	530·72
6. **Automobiles**				
McGraw ..	..	English	11 mins	530·72
7. **Battery Electricity**				
McGraw ..	..	English	11 mins	530·72
8. **Centrifugal Force**				
McGraw ..	..	English	11 mins	530·72
9. **Chemistry of Air**				
McGraw ..	..	English	11 mins	530·72
10. **Density**				
McGraw ..	..	English	11 mins	530·72
11. **Electric Circuits**				
McGraw ..	..	English	11 mins	530·72
12. **Falling Bodies**				
McGraw ..	..	English	11 mins	530·72
13. **Fire**				
McGraw ..	..	English	11 mins	530·72
14. **Force**				
McGraw ..	..	English	11 mins	530·72
15. **Friction**				
McGraw ..	..	English	11 mins	530·72
16. **Gravity and Centre of Gravity**				
McGraw ..	..	English	11 mins	530·72
17. **Heat Conduction**				
McGraw ..	..	English	11 mins	530·72
18. **Ice**				
McGraw ..	..	English	11 mins	530·72
19. **Inclined Plane, Wedge and Screw**				
McGraw ..	..	English	11 mins	530·72
20. **Inertia of Motion**				
McGraw ..	..	English	11 mins	530·72
21. **Lever**				
Mc Grow		English	11 mins	530·72
22. **Optical Illusions**				
McGraw ..	..	English	11 mins	530·72
23. **Pascal's Law**				
McGraw ..	..	English	11 mins	530·72
24. **Pendulum, The**				
McGraw ..	..	English	11 mins	530·72
25. **Properties of Gases**				
McGraw ..	..	English	11 mins	530·72

26. **Properties of Liquids**	McGraw	English		11 mins	530·72
27. **Reflection**	McGraw	English		11 mins	530·72
28. **Refraction**	McGraw	English		11 mins	530·72
29. **Sound**	McGraw	English		11 mins	530·72
30. **Static Electricity**	McGraw	English		11 mins	530·72
31. **Streamlining**	McGraw	English		11 mins	530·7
32. **Surface Tension**	McGraw	English		11 mins	530·72
33. **Wheel and Axle and Pulley**	McGraw	English		11 mins	530·72
34. **Force and Motion**	Coronet	English		11 mins	531
35. **Friction**	Tech Sc Films Ltd.	English		20 mins	531
36. **Principles of Moments**	USOE	English		33 mins	531
37. **Mechanics of Liquids**	Coronet	English		11 mins	532·2
38. **Liner Accelerator, The**	Halas & Batchelor Cartoon Films Ltd.	English		12 mins	532·7
39. **Learning about Sound**	EBF	English		8 mins	534
40. **Nature of Sound**	Coronet	English		11 mins	534·2
41. **Sound Waves and Their Sources**	EBF	English		11 mins	534·2
42. **Doppler Effect, The**	McGraw	English		9 mins	534·4
43. **Principles of Ultrasonics**	Data Films Prod. Ltd.	English		15 mins	534·5
44. **Introduction to Optics**	USNT	English		16 mins	535
45. **Measurement of Speed of Light**	McGraw	English		11 mins	535
46. **Spectrograph, the**	World Wide Pict Ltd.	English	C	20 mins	535
47. **Nature of Colour, The**	Coronet	English	C	11 mins	535·6
48. **Learning about Heat**	EBF	English		8 mins	536
49. **Nature of Heat, The**	Coronet	English		11 mins	536
50. **Car not Cycle and the Kelvin Temperature**	McGraw	English		7 mins	536·5
51. **Learning about Electric Current**	EBF	English		8 mins	537
52. **Magnetic Effect of Electricity**	FBF Silent sub-titles	English		15 mins	537
53. **Rotating Magnetic Fields**	USOE	English		13 mins	537
54. **Ohm's Law**	USOE	English		19 mins	537·1
55. **Capacitance**	USNT	English		33 mins	537·22
56. **Current and Electromotive Force**	USNT	English		11 mins	537·5
57. **National Physical Laboratory**	DFI	Hindi		12 mins	530
58. **Matter and Energy**	Coronet	English		10 mins	530·1
59. **Life of Thomas A. Edison**	Gen E With Music and and Eng sub-titles			11 mins	530·92
60. **Characteristics of Solids**	EdPS	English		9 mins	531
61. **Energy and its Transformations**	EBF	English		11 mins	531
62. **Nature of Energy**	Coronet	English		10 mins	531
63. **Simple Machines**	EBF	English		11 mins	531
64. **Galileo's Laws of Falling Bodies**	EBF	English		6 mins	531·2
65. **How to Use a Balance**	EFVA	Silent		14 mins	531·81
66. **Characteristics of Liquids**	EdPS	English		9 mins	532
67. **Archimedes Principle**	EBF	English		6 mins	532·2
68. **Characteristics of Gases**	EdPs	English		9 mins	533
69. **Fundamentals of Accounts : 2nd edn.**	EBF	English		11 mins	534
70. **Sound**	EBF	English		10 mins	534
71. **Vibratory Motion Waves**	EdPS	English		20 mins	534
72. **Sound Recording and Reproduction**	EBF	English		11 mins	534·8
73. **Light Waves and Their Uses**	EBF	English		11 mins	535
74. **Nature of Light, The**	Coronet	English		10 mins	535
75. **Nature of Colour, The**	Coronet	English		10 mins	535·6
76. **Exploring with X-Rays**	Gen E	English		40 mins	535·66
77. **Taking the X out of X-Rays**	Gen E	English		7 mins	535·66
78. **Microscope**	Shell	English		14 mins	535·8
79. **Fire**	EBF	English		11 mins	536
80. **Fuels and Heat**	EBF	English		11 mins	536
81. **Transference of Heat Series**					
82. **Conduction**	Gas CF	English		7 mins	536
83. **Convection**	Gas CF	English		8 mins	536
84. **Radiation**	Gas CF	English		6 mins	536
85. **Heat and Pressure**	EdPS	English		9 mins	536·4
86. **Thermodynamics**	DBF			11 mins	536·4
87. **Alternating Current and Direct Current**	BEDA	English		10 mins	537
88. **Coils and Electric Currents**	CCPS	English		9 mils	537
89. **Electricity and Heat**	BEDA	English		8 mils	537
90. **Electrodynamics**	EBF	English		11 mins	537
91. **Electromagnetic Induction**	BIS	English		16 mins	537
92. **Electrons**	EBF	English		11 mins	537
93. **Electron, The**	USOE	English		16 mins	537
94. **Electrostatics**	EBF	English		11 mins	537

No.	Title	Source	Language		Duration	Class
95.	Elements of Electric Circuits	EBF	English		10 mins	537
96.	Magic Magnets, Walking Oil, Rickety Oil, Energetic Light (Series 1)	GenE	English		10 mins	537
97.	Toothless Gears, some Sorters, Lamps and How(Series 2)	Gen E	English		10 mins	537
98.	Magnetism (Series 3)	Gen T	English		10 mins	537
99.	Excursions in Science and Engineering (Series 4)	Gen E	English		10 mins	537
100.	Excursions in Science and Engineering (Series 5)	Gen E	English		10 mins	537
101.	Excursions in Science and Engineering (Series 6)	Gen E	English		10 mins	537
102.	Sources of Electricity	EdPS	English		9 mins	537
103.	Making Electricity	EBF	English		11 mins	537
104.	What is Electricity	BEDA	English		13 mins	537
105.	Metal Magic	Gen E	English		10 mins	537·5
106.	Atomic Physics—in Five Parts	GBI	English		90 mins	539
107.	Atomic Theory, The—Part I	GBI	English		11 mins	539
108.	Rays from Atoms—Part II	GBI	English		13 mins	539
109.	Nuclear Structure of the Atom, The—Part III	GBI	English		20 mins	
110.	Atom Smashing—The Discovery of the Neutron—Part IV	GBI	English		22 mins	539
111.	Uranium Fission—Atomic Energy—Part V	GBI	English		24 mins	539
112.	Atomic Energy	EBF	English		11 mins	530·76
113.	Radio-Isotopes Series Fundamentals of Radioactivity	USArmy	English		59 mins	539·76
114.	Practical Procedures of Measurements	USArmy	English		48 mins	539·76
115.	Practice of Radiological Safety, The	USArmy	English		33 mins	539·76
116.	Radio-Isotope, in General Science	USArmy	English		46 mins	539·76
117.	Radio-Isotope, The : Methodology	USArmy	English		33 mins	539·76
118.	Man in Space	W.D.	English		33 mins	530·1
119.	What Do We Know About Light	CSF	English		16 mins	535
120.	Canada India Reactor	DFI	Hindi		17 mins	539·76
121.	From Tiny Grains of Sand	DFI	Hindi		13 mins	539·76
122.	Science Looks Ahead		English		10 mins	530·11
123.	Photo Emission		English		16 mins	537·54
124.	Sound Pt. I		English		9 mins	534
125.	Sound Pt. II		English		9 mins	534
126.	Sound Pt. III		English		16 mins	534
127.	Sound Pt. IV		English		11 mins	534
128.	Light Pt. I		English		9 mins	535
129.	Light Pt. II		English		11 mins	535
130.	Light Pt. III		English		6 mins	535
131.	Light Pt. IV		English		10 mins	535
132.	Atomic Energy in Canada		English		28 mins	539·76
133.	Refrigeration	McGraw	English		11 mins	530·72
134.	Electricity / Movement	BEDA	English		11 mins	537

MATHEMATICS

No.	Title	Source	Language		Duration	Class
1.	What are Decimals	Inst F	English	C	10 mins	511
2.	Meaning of PI, The	Coronet	English		11 mins	513
3.	Descriptive Geometry	UW	English		22 mins	515
4.	Addition is Easy	Coronet	English		11 mins	511
5.	Division is Easy	Coronet	English		11 mins	511
6.	Meaning of Long Division	EBF	English		16 mins	511
7.	Multiplication is Easy	Coronet	English		10 mins	511
8.	Subtraction is Easy	Coronet	English		10 mins	511
9.	We Discover Fractions	Coronet	English		10 mins	511
10.	What are Fractions	Films	English		10 mins	511
11.	Geometry and You	Coronet	English		10 mins	513

BOTANY

No.	Title	Source	Language		Duration	Class
1.	Garden Plants and How They Grow	Coronet	English		11 mins	580
2.	Power of Plants	Almanac	English		11 mins	581
3.	Gift of Green, The	NYBG	English	C	20 mins	581·1
4.	Plants and Water	CSF	English		22 mins	581·11
5.	Seed Dispersal	EBF	English		11 mins	581·16
6.	Life in a Pond	Coronet	English		11 mins	581·92
7.	Climbing Plants	GB	English		20 mins	582
8.	Dandelion, The	GB	English		10 mins	583
9.	Life of a Plant	EBF	English	C	11 mins	583·3
10.	Life Story of a Water Mould, The	Calif U	English		11 mins	589
11.	Bacteria—Friend and foe	EBF	English	C	10 mins	589·9
12.	From Flower to Fruit	EBF	Silent		15 mins	581
13.	How Beans Grow	EdPS	Silent		12 mins	581
14.	How Plants Feed	GBI	English		10 mins	581
15.	Interdependence of Plant and Animal Life	Bray	Silent		15 mins	581
16.	Leaves	EBF	English		11 mins	581
17.	Life Cycle of the Onion, The	GBI	English		11 mins	581

No.	Title / Producer	Language		Duration	Class
18.	**Photosynthesis** GBI	English		20 mins	581
19.	**Roots** GBI	English		10 mins	581
20.	**Seed Dispersal**				
21.	**Wind Dispersal—Part I** GBI	English		8 mins	581·16
22.	**Animal Dispersal—Part II** GBI	English		5 mins	581·16
23.	**Exploding Fruits—Part III** GBI	English		6 mins	581·16
24.	**Seed Burial—Part IV** GBI	English		8 mins	581·16
25.	**Dispersal of Seeds** EdPS	Silent		12 mins	581·16
26.	**Self Defence by Plants** GBI	English		11 mins	581·5
27.	**Growth of Flowers, The** Coronet	English		11 mins	582·13
28.	**Pollination** GBI	English		8 mins	582·13
29.	**Seasonal Changes in Trees** Coronet	English		10 mins	582·16
30.	**Life Cycle of Maize, The** BCF	English		10 mins	584·8
31.	**Life Story of a Fern** GBI	English		20 mins	587
32.	**Pasetur's Legacy** MFC	English		24 mins	589·9
33.	**Herbarium**	Hindi		12 mins	580·742
34.	**Microscopie Fungi**	English		16 mins	589·1
35.	**Birth of a Florida Key**	English		14 mins	581·1
36.	**Fruits Broadcast by Explosion**	English		10 mins	581·16
37.	**Fruits Broadcast by Wind**	English		10 mins	581·16
38.	**Fruits that Bore into the Earth**	English		10 mins	581·16

ZOOLOGY

No.	Title / Producer	Language		Duration	Class
1.	**Mother Hen's Family** Coronet	English		11 mins	591·3
2.	**Maze Reaction in Normal and Thyroidectomized Sheep** BCR	Silent sub-titles in English		10 mins	591·44
3.	**Camouflage in Nature Through Pattern Matching** Coronet	English	C	8 mins	591·5
4.	**Children's Magazine : No. 1** DFI	Hindi		11 mins	591·5
5.	**Gray Squirrel** EBF	English		11 mins	591·5
6.	**How Animals Defend Themselves** YAF	English		10 mins	591·5
7.	**How Animals Move** YAF ..	English		10 mins	591·5
8.	**How Nature Protects Animals** EBF	English		11 mins	591·5
9.	**Zoo Babies** Coronet	English	C	11 mins	591·5
10.	**Life in a Drop of Water** Coronet	English		11 mins	591·8
11.	**Fight for Life** CFC	English		16 mins	591·9
12.	**Marine Communities** ISU	Silent	C	15 mins	591·92
13.	**Amoeba, The** GB	English		11 mins	593·1
14.	**Amoeba, The** UW	English		10 mins	593·1
15.	**Protozoa** EBF	Silent sub-titles in English		15 mins	593·1
16.	**Tiny Water Animals** EBF	English		10 mins	593·1
17.	**Fasciola : The Life-History of a Trematode** GB	English		19 mins	595·12
18.	**Bed Bugs, The** GH	English		11 mins	595·75
19.	**Blow Fly, The** GB	English		22 mins	595·77
20.	**Life Cycle of the Sawfly** GB	English		9 mins	595·77
21.	**Looper Cater Pillars** GB	English		8 mins	595·78
22.	**Story cf Butterfly** Bray	Silent		11 mins	595·78
23.	**Wood Ants** GB	English		11 mins	595·796
24.	**Honey Bee, The : A Social Insect** Coronet ..	English		6 mins	595·799
25.	**Underwater Spearfishing** FON ..	English		14 mins	597
26.	**Poisonous Snakes** Sovexport	English		35 mins	597·12
27.	**Life History of the Frog** GB	English		18 mins	597·8
28.	**Birds are Interesting** EBF	English		11 mins	598·2
29.	**How Birds Feed Their Young** EBF	Silent sub-titles in English	C	15 mins	598·2
30.	**Kingdom on the Waters, A** HD	English	C	86 mins	598·2
31.	**Life Story of the Tawny Owl** GB	English		9 mins	598·2
32.	**Ostriches in Africa** BH	Silent	C	7 mins	598·2
33.	**Kangaroos** AIF	English		11 mins	598·2
34.	**Tale of the Woods, A** Sovexport	Hindi	C	60 mins	599·32
35.	**Animals of the Cat Tribe** EBF	Silent		5 mins	599·744
36.	**Three Little Bruins in the Woods** Castle	English		10 mins	599·744
37.	**Monkeys and Apes** EBF	Silent sub-titles in English		8 mins	599·8
38.	**Animal Life** EBF	English		10 mins	590
39.	**Reproduction in Higher Forms of Life** Bray	Silent		16 mins	591.16
40.	**Animals Growing Up** EBF	English		11 mins	591·3
41.	**Development of a Bird Embryo** EBF	Silent		15 mins	591·3
42.	**How Animal Life Begins** USDA	English		10 mins	591·3
43.	**Reproduction Among Mammals** ECF	English		11 mins	591·33
44.	**Adventures of Bunny Rabbit** EBF	English		11 mins	591·5
45.	**Animal Movement** GBI	English		10 mins	591·5
46.	**Animals Unlimited** FON	English		20 mins	591·5
47.	**Black Bear Twins** EBF	English		11 mins	591·5
48.	**Camouflage in Nature : Through Form and Colour Matching** Coronet	English	C	10 mins	591·5

No.	Title / Producer	Language	Colour	Duration	Class No.
49.	**Common Animals of the Woods** EBF	English		11 mins	591·5
50.	**Feeding Time at the Zoo** GBI	English		10 mins	591·5
51.	**In Our Garden** EdPS	Silent		12 mins	591·5
52.	**Jungle Marauder** Official	English		11 mins	591·5
53.	**Live Teddy Bears** EBF	English		11 mins	591·5
54.	**Our Animal Neighbours** Coronet	English		10 mins	591·5
55.	**Round the London Zoo** Peak	Silent		13 mins	591·5
56.	**Wing, Claw and Fang** UW-Cast	English		10 mins	591·5
57.	**Zoo's Who** Official	English		9 mins	591·5
58.	**Marine Marvels** DFI	Hindi		11 mins	591·9
59.	**Facts about Fish** GBI	English		9 mins	591·92
60.	**Giants of the Sea** Official	English		10 mins	591·92
61.	**Sea Urchin, The—Part I** GBI	English		11 mins	591·92
62.	**Sea Urchin, The—Part II** GBI	English		12 mins	591·92
63.	**Under Sea Life** Official	English		10 mins	591·92
64.	**Life on Western Marshes** NFBC	English		15 mins	591·92
65.	**Ameoba, The** EdPS	Silent		12 mins	593·1
66.	**Amoeba and Vorticella** EdPS	English		9 mins	593·1
67.	**Microscopic Animal Life** EBF	Silent		15 mins	593·1
68.	**Hydra, The** EdPS	Silent		12 mins	593·7
69.	**Life of a Fresh Waterpolyip, The** GBI	English		9 mins	593·7
70.	**Annelid Worms** GBI	English		10 mins	595·1
71.	**Earthworm** EdPS	English		9 mins	595·1
72.	**Crustacea** GBI	English		20 mins	595·3
73.	**Arachnida** GBI	English		22 mins	595·3
74.	**Onychophora and Myriapoda** GBI	English		10 mins	595·5
75.	**Friend and Foe** DFI	Hindi/ English		10 mins	595·7
76.	**Insect Zoo** EBF	English		11 mins	595·7
77.	**Killer of the Insect World** Pictorial	English		11 mins	595·7
78.	**Grasshopper, The** EdPS	English		9 mins	595·72
79.	**Fly as a Disease Carrier** Bray	Silent		15 mins	595·77
80.	**Mosquitoes and Malaria** EdPS	English		9 mins	595·77
81.	**Mosquito, The** EBF	English		11 mins	595·77
82.	**Swat the Fly** EdPS	English		9 mins	595·77
83.	**Winged Scourage** OIAA	English	C	10 mins	595·77
84.	**Emperor Moth, The** GBI	English		11 mins	595·78
85.	**Monarch Butterfly Story** EBF	English	C	11 mins	595·78
86.	**Ants** EBF	English		11 mins	595·796
87.	**Meadow Ant** GBI	English		10 mins	595·796
88.	**Story of the Bees** UW-Edu.	English		22 mins	595·799
89.	**Dogfish as a Vertebrate, The** GBI	English		19 mins	597
90.	**Sunfish** EBF	English		11 mins	597
91.	**Snapping Turtle** EBF	English		11 mins	598·13
92.	**Bird Sanctuary** GBI	English		23 mins	598·2
93.	**Birds of Prey** EBF	English		11 mins	598·2
94.	**Penguin Island** BIF	Silent		6 mins	598·2
95.	**Sparrow Hawk, The** GBI	English		11 mins	598·2
96.	**Jitmouse the Weaver** BIF	Silent		6 mins	598·2
97.	**Warblers, The** GBI	English		9 mins	598·2
98.	**Water Birds** EBF	English		11 mins	598·2
99.	**Winged Messengers** DFI	Silent		8 mins	598·2
100.	**Birds of Canada—No. 3** NFBC	English		11 mins	598·29
101.	**Birds of Canada—No. 4** NFBC	English		11 mins	598·29
102.	**Birds of Canada—No. 5** NFBC	English		10 mins	598·29
103.	**Development of the Rabbit, The** DCF	English		35 mins	599
104.	**In the Beginning** USDA	English		18 mins	599·32
105.	**Elephants** EBF	English		11 mins	599·61
106.	**Cow and its Relatives** Coronet	English		10 mins	599·7
107.	**Deer and its Relatives** Coronet	English		10 mins	599·7
108.	**Indian Water Birds** DFI	Hindi/ English		28 mins	598·20954
109.	**Animal Friend**	English		11 mins	590·744
110.	**Day at the Zoo, A**	Hindi/ English		35 mins	590·74
111.	**Lets Look at Wees**	English		19 mins	595·1
112.	**Our Feathered Friends**	Hindi		16 mins	598·20954
113.	**Fright and Prejudice** DFI	Hindi English		11 mins	598·12
114.	**Spider Engineer**	English		15 mins	595·44
115.	**Butterfly Mystery**	English		11 mins	595·7
116.	**Emergence of a Dragonfly**	English		6 mins	595·7
117.	**Blind as a Bat**	English		9 mins	599·4

"PLANET EARTH" SERIES

(These films are available with the United States Information Service, New Delhi. Annotations, Courtesy : USIS Film Catalogue.)

A series of 13 colour films in English, each 27 minutes in length, produced by the National Academy of Sciences of the United States. The films synthesise man's knowledge of his physical environment, and also delineate newly-developed and powerful tools for gathering data on space and the cosmos. Although the inspiration for the series came from the International Geophysical Year, the films give a rounded picture of man's quest for knowledge in each field, outlining the principal discoveries and ideas and raising questions that still challenge science both as regards the cosmos and the earth itself. Extensive film footage was shot for the series in all parts of the world both during and after the International Geophysical Year.

CHALLENGE OF THE OCEANS

The physical aspects of the ocean are examined, including the variety of currents in the ocean, the relationship of the dynamics of the oceans to weather and climate, and the composition of ocean waters. The life cycle in the oceans is sketched. Topography and composition of ocean bottoms are delineated, and the structure and content of the sediments are portrayed.

COSMIC RAYS

A detailed examination of present concepts of the origin and nature of charged particles reaching the earth from outer space. Recent discoveries—using balloons, rockets and satellites—are presented. The relationship between cosmic ray research and nuclear research is outlined.

FLAMING SKY, THE

The nature of the aurora—the mysterious northern and southern lights—is explored. The development of modern understanding of this phenomenon is traced from the ancient Romans to present beliefs that relate the aurora to emission of charged particles from the sun. The film examines present scientific thinking on what the aurora is, what causes it, and its relationship to other events in man's physical environment, including the earth's magnetic field, radio waves, and solar activity.

FORCE OF GRAVITY, THE

The nature of gravitation is examined. The role of the gravitational field in accounting for the motions of planets is described. Newtonian and Einsteinian theories are explained and contrasted; gravitational problems of the space age are introduced.

HIDDEN EARTH, THE

The structure of the solid earth is analysed from the crust, through the mantle, to the central core. The dynamic quality of the "solid earth" is demonstrated through analysis of earthquakes and volcanoes. Application of seismology to the study of other planets is introduced.

INCONSTANT AIR, THE

Man's early efforts to measure pressure and temperature afford a basis for understanding the phenomena that make up both weather and climate. Circulation of the atmosphere and the role of energy from the sun is portrayed. How meteorological data are collected and how weather forecasts are arrived at are discussed. Theories on climatic changes and how they might come about are described. Current research in the laboratory and using satellite vehicles is presented.

MAGNETIC FORCE

Beginning with early speculations, the film explains the nature of the earth's magnetic field. The magnetic field within the earth and that existing in space are described. Shows how the magnetic field controls the path of cosmic ray particles and other charged particles that make up the aurora. The manner in which magnetic force provides a man with a better understanding of the earth and the far reaches of the universe is described.

THE NEAREST STAR

The properties of the sun and the relationship of solar activity of the earth are explained. Such events as sunspots and solar flares, which exert a profound influence on the earth's upper atmosphere, are portrayed. The effect of particles and radiations from the sun on man's environment is analysed.

RADIO WAVES

Both man-made and natural radio waves are discussed beginning with Hertiz's discoveries in the 19th century. The influence of the ionosphere on radio waves is explained. The relationship between radio waves, the ionosphere, the earth's magnetic force and solar activity is delineated. The new science of radio astronomy, which seeks to learn more

about the universe from radio waves coming to the earth from space beyond our solar system, is described.

RESEARCH BY ROCKETS

The exploration of the upper atmosphere by instruments carried aloft by rockets is explained. The analysis of these data, are stressed. The significance of history of man's attempts to reach out into the higher atmosphere is portrayed and the variety of modern rocket vehicles, including their principles of operation, is shown. Significant discoveries relating to the atmosphere, ionosphere, the earth's magnetic field, cosmic rays, the aurora, and radiations from the sun are examined.

SCIENCE IN SPACE

Scientific exploration of space and its contents and the placing of satellites in orbit are explained. Shows significant discoveries of modern space science, including the Van Allen radiation belts. Radio and optical methods of tracking satellites, the telemetry of data from satellites and space probes to earth, and the analysis of these data are stressed. The significance of satellites and space probes to man's understanding of the cosmos is underlined.

SECRETS OF THE ICE

The role of snow and ice on man's physical environment is explained. Mountain glaciers and the ice fields of Greenland and Antarctica are explored with research parties. The relationship between glaciology, on the one hand, and oceanography and weather, on the other is explained.

SHAPE OF THE EARTH, THE

The study of the size and shape of the earth is presented from ancient times to present concepts derived from data obtained from orbiting satellites. Present efforts to define and perfect man's knowledge of the shape of the earth are outlined and the relationship of this effort to future problem of navigation in space is explained. The determination of position and of distance on the earth by astronomical means is examined.

AUDIO VISUAL EDUCATION OFFICERS CONFERENCE—A SHORT REPORT

(Continued from page 24)

taking such a project. At present only about 10 per cent of the total number of 21,000 secondary schools have 16 mm. projecting equipment of their own. Classroom usage of films will be possible only if schools are assured an adequate supply of basic instructional type of films.

Secondly, when 8 mm. educational films are being considered at present for classroom use, single concept, loop films would definitely prove helpful in enriching the subject matter taught through films. Therefore, along with one 16 mm. projector for each school, it is proposed to include additional projecting equipment consisting to two 8 mm. silent casset loading projectors and one filmstrip projector. The total cost of these three projectors will not exceed Rs. 4,000.00 when they are purchased in bulk. The total expenditure for this crash programme at the National level will be about Rs. 17 crores.

Paper VI : Organization of State Film Libraries and Allied Audio Visual Services. (by *Miss K. Roy*)

The paper stressed the need for developing State Films Libraries & Allied Audio Visual Services and highlighted the following for the proper functioning of a Film Library and Allied Audio Visual Services.

(i) *Selection of Proper Material*

(ii) *Storage and Upkeep of Materials*

(iii) *Circulation and Utilization of Materials*

Paper VII : Methodology of Educational Research with special reference to Audio Visual Aids. (by *P. N. Khanna*)

The paper highlights the need for the application of methods of research to educational problems especially in the field of audio visual education, where research is still in its infancy. There are many questions concerning the use of Instructional materials, from the primary to the high school level, for which we have no answer.

The paper makes a plea for setting up of research units in the States and outlines the role that the National Institute of Audio Visual Education can play in order to help these units. The minimum staff required for the purpose is one Research Officer. This Unit can be strengthened as more and more funds are made available. The National Institute of Audio Visual Education can help the States by giving proper guidance and also taking up the problems which are of an important and immediate nature.

Section IV : Summary of the Recommendations and Resolutions of the Conference.

General :

(i) Conferences of this type should be made an annual feature. The holding of such conferences in different States is desirable.

(ii) National Institute of Audio Visual Education should send its officers to the State Departments of Audio Visual Education whenever they plan to develop Audio Visual programmes. The Institute should make budget provisions for this help.

(iii) National Institute of Audio Visual Education should send assessment committees to different States to assess their programmes.

(iv) A panel for inter-ministerial coordination of Audio Visual information and services be developed with National Institute of Audio Visual Education as the clearing house.

(v) Voluntary organisations should be given proper recognition and financed by the Government of India and the States.

(vi) Monthly newsletters should be brought out by all the States and National Institute of Audio Visual Education.

(vii) States may levy an annual fee of Re. 1 on every student towards Audio Visual funds. This will help the schools to raise their own funds for the purchase of Audio Visual Aids, and equipment.

LEARNING BY DISCOVERY

(Continued from page 4)

Students of creative thinking have suggested three ways of looking at any operation or institution to minify, to magnify, or to rearrange. Several of these approaches have been noted above.

We have seen that learning by discovery is a search for new meanings, for developing transferable generalizations drawn from concrete experience. We abstract these experiences from their specific concepts and generalize them, often in verbal form. Some writers have pointed out, however, that there is danger in premature abstractions, in verbalizing too soon. Further, we can successfully generalized without verbalizing. We face the twin hazards of getting stuck in the concrete or lost in the misty clouds of abstraction.

Harold D. Lasswell in *Psychology and Politics* warns about the dangers of the too sedulous cultivation of logical thinking and notes that the frames of reference can become restrictive, uncreative. There develops an intolerance of "the immediate, unanalyzed, primitive abundance of the mind". To learn by discovery we must soak ourselves in our subject, and avoid the hazards of premature abstraction without depth in understanding. Amiel put it this way : "To understand is to possess the thing understood, first by sympathy and then by intelligence".

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